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OPERATION OF STEAM TURBINE PLANTS

Practical Considerations Necessary to Success; Importance of Proper Foundations

By W. J. A. LONDON

BESIDES THE TROUBLES THAT may be justly called legitimate, namely, those that cannot always be avoided in the best of machinery due to oversight in design, defective material or workmanship, there are troubles peculiar to the turbine installation that may be a constant source of worry to the engineer in charge, particularly as these troubles appear to an engineer with reciprocating engine experience only as being without reasonable cause. These troubles are often traceable to one or both of the following causes:

1. Incorrect design of the foundation, piping, etc. to insure satisfactory operation after installation, and lack of necessary attention to setting and alignment of the machine and piping when originally installed.

2. Inexperience of the operating engineer with turbines; neglect of the instructions issued by the manufacturer, and ignorance of the fundamental principles of the design of these machines which require a different treatment when in operation from the reciprocating engine.

It is astonishing the number of installations where trouble has been experienced due to nothing else than the improper design of foundation or installation in the first instance, or both. Prevention is better than cure and often much easier and for that reason a careful consideration of conditions before the installations of the machine is of the utmost importance.

Need for Good Foundations

IT is often stated in favor of the steam turbine over the reciprocating engine that little or no special foundations are necessary. This is true to a great extent, as shown by the light and temporary foundations used by most of the turbine builders on their testing floors, and also in the number of installations where machines are installed for temporary operation mounted on nothing more than a pair of skids. But while a machine will operate and operate satisfactorily on such a foundation, if vibration and elimination of noise as far as possible is an important factor, the foundation is a different proposition, and an important one at that, especially in a power house in a thickly populated locality, or in an office or hotel building.

In the case of horizontal turbines, the condenser and auxiliary apparatus are almost invariably placed in the basement of the power house, or in other words,

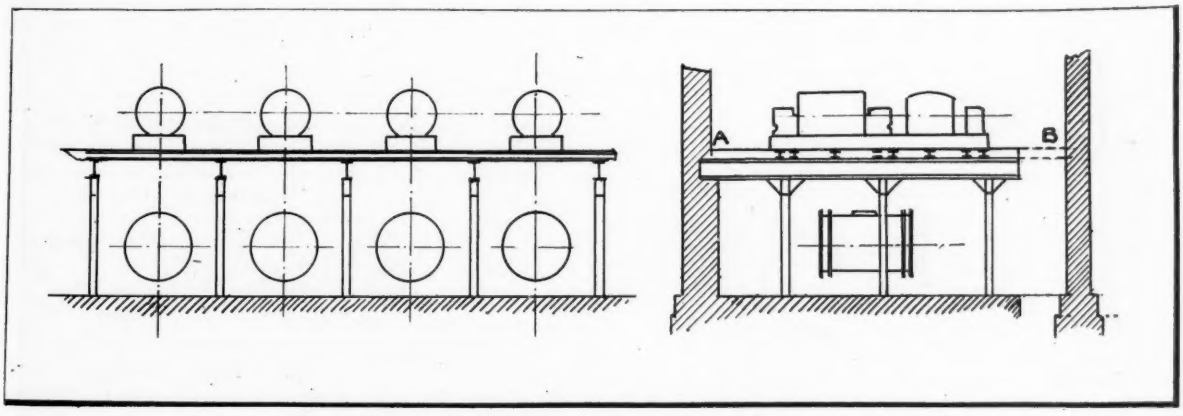


FIG. 1. ALL STEEL CONSTRUCTION OF STEAM TURBINE FOUNDATIONS

the main turbine room is one story above the main building foundations, and in order to save total floor space, long exhaust piping, etc., the turbines are generally placed directly above the condenser.

Types of Foundations

IN the larger units where surface condensers are employed, the auxiliary apparatus takes up more floor space than the turbine, therefore it is necessary to

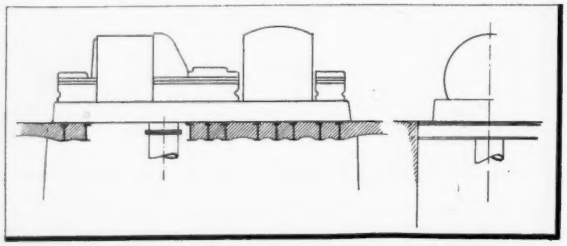


FIG. 2. CONCRETE AND STEEL FOUNDATION

have as much clear space in the basement as possible, and to obtain this the "all steel" construction of floor is often resorted to, as shown in Fig. 1.

While this gives an ideal arrangement as far as accessibility is concerned, it is not by any means an ideal construction for turbine foundations. The girders may be made stiff enough to carry the dead weight, but vibrations are liable to be created in the steel work, which may prove very objectionable.

In this construction it is the general practice to grout the floor girders into the main building walls as shown at A. Another and better method, however, and that used in some of the latest power houses, is to keep the floor girders entirely separate from the walls as shown at B—thus preventing the vibrations of the floor being transmitted to the main building wall.

A somewhat better arrangement is the concrete and steel construction as shown in Fig. 2. This, of course, does not give the same available basement space as the previous arrangement, but gives a much more rigid construction, inasmuch as it breaks up the steel construction and eliminates the transmission of vibration throughout the room, and prevents vibration being intensified by succeeding machines.

While a turbine may be balanced so perfectly that by standing on the bedplate one feels absolutely no vibration at all, it is sometimes possible to feel these vibrations in other parts of the building, due purely to harmonic action, the speed of the turbine being so high that this can be readily understood.

Figure 3 shows the all concrete construction, and where possible this construction should always be resorted to. This, of course, leaves less room in the basement than in either of the designs shown in Fig. 1 or 2, and it also has the disadvantage that the auxiliary apparatus must be placed in position before the foundations are completed, and in case of replacements is a a very big handicap, but replacement of such parts as condensers is so rare that this objection may be considered almost negligible.

European and American practice has differed all along to a great extent with regard to the foundations best suited for turbine work. The European builders have always favored the all concrete construction, and while the steel and concrete has been adopted in many cases, the tendency is to return exclusively to the all concrete design. Figure 3 shows a typical European installation with the relative position of the auxiliaries.

In vertical turbines the all concrete construction is almost invariably used, as there is no reason for resorting to anything else. In the case of turbines fitted with sub-base condensers, the condensers rest on the main foundations and the main turbine is built above this. With separate condensers they are generally placed at the side of the machines, still keeping to the solid concrete construction for the main turbine.

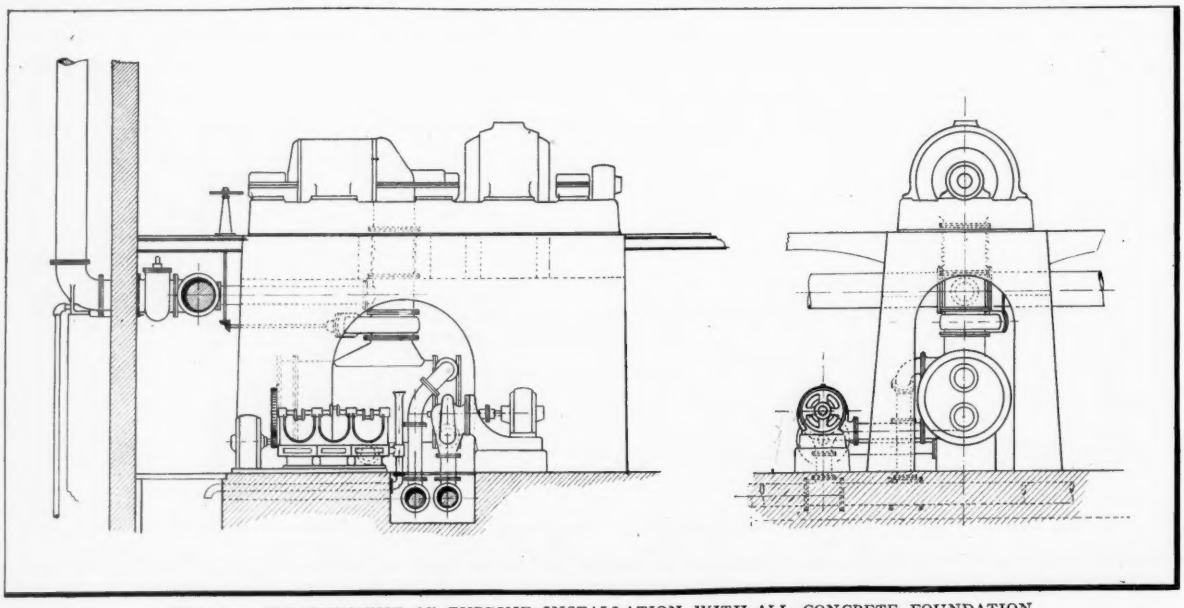


FIG. 3. ARRANGEMENT OF TURBINE INSTALLATION WITH ALL CONCRETE FOUNDATION

Foundations for Auxiliaries

IN the case of auxiliaries where small turbines are used for driving them, their location is the principal point in determining the foundations necessary. If placed in the basement, the usual grouted in method is, of course, the most satisfactory, as then they are on a

perfectly rigid foundation and not liable to get out of line, or give vibration troubles. If, however, they are placed in the engine room or on the second floor and the floor is of steel construction, particular attention should be paid to their location, if quiet operation is to be expected. The worst possible position is, of course, that shown in Fig. 4 and vibration troubles will often be experienced with this arrangement.

In auxiliary machinery, such as pumps, blowers, etc., the elimination of vibration is often impossible, as will be explained in a later article. It is, therefore, always advisable to place auxiliaries near the wall, or on solid concrete wherever possible. If it is necessary to place them as shown in Fig. 4, a bed of concrete should be placed between the turbine and the floor, and preferably a support placed under the girders at C in order to break up the vibration of the girder by giving the effect of placing the machine at the end of 2 short girders instead of in the middle of one long one. If the small turbine is driving a small generator for excitation purposes, more precaution should be taken than with a pumping set, inasmuch as commutation troubles often follow in the wake of vibration in the unit.

In the case of small units for office buildings, hotels, etc., these must be considered from a different view point. Noise and vibration that would be considered negligible in a central station would often be found prohibitive in an office or hotel installation. Steel plays such an important part in the majority of these buildings that all direct communication between the turbine and the building should be avoided.

In installations of this order, it has been the practice in Europe for many years to mount the machines on some good damping medium, such as wood and lead or alternate layers of felt and wood, etc. No holding down bolts, of course, being used. The actual foundations are, of course, of concrete with a platform or plinth raised above the floor level, special care being taken to make this plaform absolutely level, as no grouting is used. If it is possible to build up the foundations of the machine separate from those of the main building, so much the better, but if this is not possible, then the damping medium between the foundation and the base of the turbine must be sufficient to prevent the transmission of vibration to the main building structure.

Size of Foundation

WITH reference to the dimensions and proportions of the foundations required, it is, of course, impossible to give any specific data, as so much depends upon the nature of the ground. The manufacturer gives the weight of his apparatus and in the horizontal turbine, as the weight is unevenly distributed, it is the custom for the manufacturer to give the distribution of said weights. In the case of steel foundation he specifies the dimensions of scantlings and girders required, as there is a maximum to the amount of distortion that is permissible; this is sometimes given as .030 in.

While a construction sufficient to carry the dead weight is all that is theretically necessary a considerable allowance should be made over this to provide against cracking or distortion due to shocks caused by, say, a slug of water in the turbine or the switching in of a generator out of phase.

Every precaution should be taken to prevent sinking or settling, or any distortion that would tend to thrown the machine out of line. It must be borne in mind that while the turbine may be fitted with a substantial bedplate, few bedplates are sufficiently strong to keep the machine in line should the foundations give way.

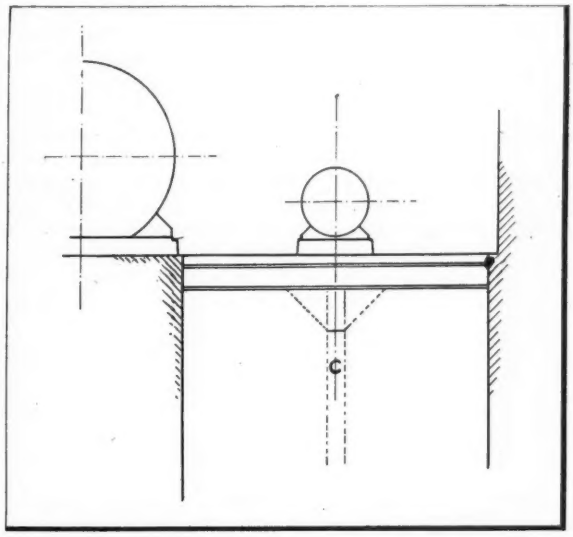


FIG. 4. FOUNDATION FOR AUXILIARY WITH POST SUPPORT

In the installation of steam turbines, it is strongly recommended that the contractor be consulted more freely than is at present the case with regard to the proposed foundations and layout, as there are so many points that the customer who, hertofore, has had experience only with reciprocating engines is liable to overlook; and it is to the advantage of the contractor to give all the advice he can to the customer in this respect in order to insure his apparatus working satisfactorily after installation.

GOVERNMENT FORMULA FOR WHITEWASH

SLAKE half a bushel of quick lime with boiling water. Keep it covered during the process. When the lime is thoroughly slaked, add one peck of salt. It will be necessary to add more water as the salt is added, in order to keep the whitewash at the proper consistency; or the salt may be dissolved separately in as small an amount of hot water as will absorb readily. The proper consistency for whitewash is a thin paste, and it may be tempered as it is used. To each 12-quart pail of whitewash, composed of lime and salt as above add a good, fair handful of Portland cement and about a teaspoonful of ultramarine blue. The cement and blue should be added only as the wash is being used and should be thoroughly stirred into the whitewash; otherwise, when applied, it will be streaked. Cement is used for the purpose of giving the whitewash a better setting property so as to make it adhere better to the surface to which it is applied. The ultramarine blue is used simply to counteract the brownish color of the Portland cement, and in many cases the ultramarine blue may be dispensed with. It is, however, best to use a small amount, say half a teaspoonful to the pail, as a whiter surface results. The wash should be strained through a fine wire-cloth strainer before using, to remove the lumps if there are any present.

ENGINE TEST FROM THE INDICATOR DIAGRAM*

Determination of Clearance, Leakage, and Valve Setting, by the Use of Logarithmic Section Paper

By J. Paul Clayton

FIGURES of one set of indicator diagrams and the corresponding set of logarithmic diagrams are numbered the same, but the letters A and B are used in addition to the figure number to denote the indicator and logarithmic diagrams, respectively.

In the cases of the great majority of the PV-diagrams which were examined, the expansion and compression curves became straight lines in the logarithmic diagram, showing n to be a constant for any one curve. The clearances furnished with the diagrams examined had been carefully found by the displacement method.

It was desired to see what forms the lines assumed when the clearance was taken larger or smaller than the measured quantity. The diagram shown in Fig. 5A,

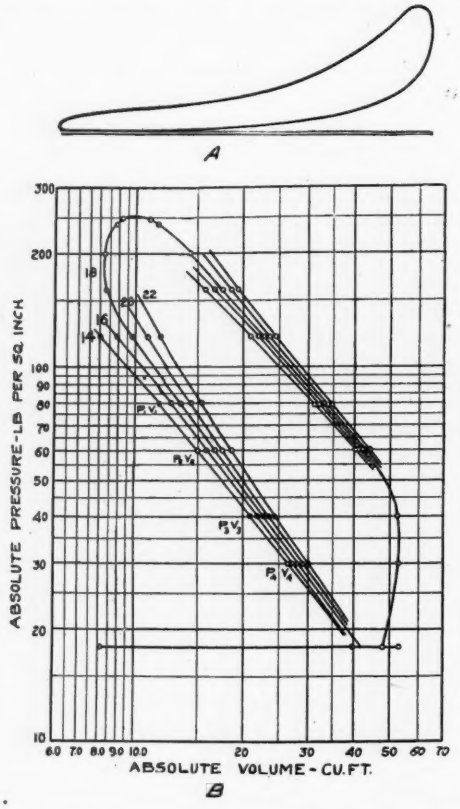


FIG. 5. A, INDICATOR DIAGRAM FROM 42 BY 60-IN. GAS ENGINE USING BLAST FURNACE GAS. B, LOGARITHMIC DIAGRAM AND PLOTS OF EXPANSION AND COMPRESSION CURVES WITH CLEARANCE TAKEN TOO LARGE AND TOO SMALL

taken from a 42 by 60-in. gas engine, was used for this purpose. The true clearance, measured as 18.0 per cent, was used in the full logarithmic diagram of Fig. 5B. Trials were made with clearances assumed as 14.0, 16.0, 20.0, and 22.0 per cent of the piston displacement. With the true clearance of 18.0 per cent, the curves became almost perfectly straight lines, while with the values of clearance less than 18.0 per cent, it is seen that the lines become bent to the left, and with values of over 18.0 per cent the lines become bent to the right. Hence the straight line for the value of 18.0 per cent is the transition between the family of curves bending to the left, representing a clearance smaller than the real value, and the family of curves bending to the right, representing a clearance larger than the real value.

The graphical method of approximating clearance requires only the scale of the indicator spring to be known, and the atmospheric line to be drawn, in order to locate the zero line of pressure. The exact order of procedure necessary to make a trial, and the degree of accuracy obtained in any given case, is here shown for a 25⅝ by 37⅝-in. gas engine. All that is necessary is to assume different values of clearance, and plot the logarithmic diagram for each assumed value. The straight line position of the curves is found by trial and error, to lie between the 2 diverging families of curves representing too small and too large clearance.

It was desired to determine the clearance of the diagram shown in Fig. 6A. From general knowledge of this class of engines a trial by the graphical method was made in Fig. 6B with the clearance assumed as 12.4 per cent, a value purposely assumed as being too small. The value is seen, by the bending of both curves to the left, to be much too small. Trials were, therefore, made with the clearance assumed as 13.8, 15.1 and 16.0 per cent of the piston displacement.

The value of 15.1 per cent gave practically straight lines for both the expansion and compression curves, while the value of 16.0 per cent shows that the lines have begun to bend to the right, indicating too large a clearance. By inspection, it will be seen that the region of fairly straight lines may be located as lying between the values of about 14.5 per cent to 15.5 per cent. The clearance is, therefore, selected as 15.0 per cent, a value which may be high or low but not more than 4 per cent in this case. This clearance value, 15.0 per cent, is a common value for engines of this class.

The graphical method is more accurate for large clearances, measured in per cent of the piston displacement, than for small ones. The closeness of location of the straight-line region, lying between 2 families of diverging curves, will be found to be within 5 to 10 per cent of the clearance volume, for values of clearance between 20 per cent and 2 per cent, respectively, of the piston displacement.

Locating the Position of Events of the Stroke

IT is often desirable to know at what part of the stroke the cyclic events occur. This knowledge can be best obtained from the diagram. For ordinary purposes, these events can be closely located by inspection on the diagrams themselves, in most cases; thus, on a diagram from a Corliss engine, cutoffs may generally be located to within $^1/_{16}$ in., measured along the length of the diagram.

The actual beginning of true compression, however, can never be accurately located on the indicator diagram. True compression, unaffected by leakage, begins after the exhaust valve, in closing, has acquired enough seal to prevent leakage, the point at the beginning of true compression being generally at least 5 lb. above the back pressure. The point at which leakage ceases cannot be located on the PV diagram because the curve of true compression, and the curve during the time the valve

*Continued from page 526 of the May 15th issue.

located on the PV diagram because the curve of true compression, and the curve during the time the valve has insufficient seal, are of the same direction of curvature, and are not reverse curves as in the general case of admission and expansion.

The fact that expansion and compression of a constant weight of medium gives straight lines in the logarithmic diagram, enables us to locate cyclic events very closely.

An example is shown in Fig. 7A of locomotive diagrams taken at short cutoff and high speed. The events of cutoff, release, compression, and admission are very difficult to locate on such diagrams. These events are located on the logarithmic diagram in Fig. 7B by noting when the expansion and compression curves become straight, indicating a constant weight of steam mixture.

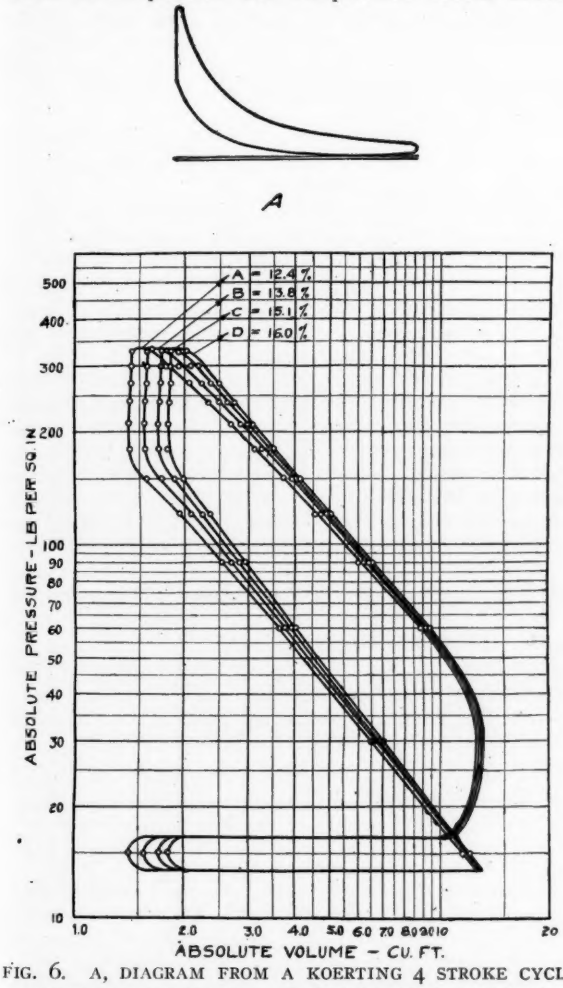


FIG. 6. A, DIAGRAM FROM A KOERTING 4 STROKE CYCLE PRODUCER GAS ENGINE. B, LOGARITHMIC DIAGRAM CONSTRUCTION TO DETERMINE CLEARANCE

A sufficient number of points are plotted to show clearly the direction of the diagram near the events desired. Thus these events, even though obscure in the PV diagram, may be located to well within about $^1/_{16}$ in. in the logarithmic diagram, this length being equivalent to about $^1/_{32}$ in. when transferred to the PV diagram.

Detecting Leakage

THE law $PV^n = C$ is applicable only to cases where the weight of the working medium remains practically constant during any expansion or compression. When this weight changes materially, either by leakage into or out from the cylinder containing the medium, the resulting expansion or compression no longer obeys the law, and the line becomes a curve on logarithmic cross-section paper. This fact is clearly shown in curves of the logarithmic diagram derived from cylinders in which large leaks were known to exist.

The first case, shown in Fig. 8, occurred in a 10 by 19-in. gas engine, intended for producer gas, but using illuminating gas at high compression. The piston, a single-acting trunk pipe, allowed a large leak, clearly detected by the noise of escaping gas, at the beginning of the combustion stroke. Both the compression and expansion curves show the effect of this leak in a clear manner when transferred to the logarithmic form. After that portion of the stroke was reached where no sound of leakage was heard, the 2 curves became straight lines.

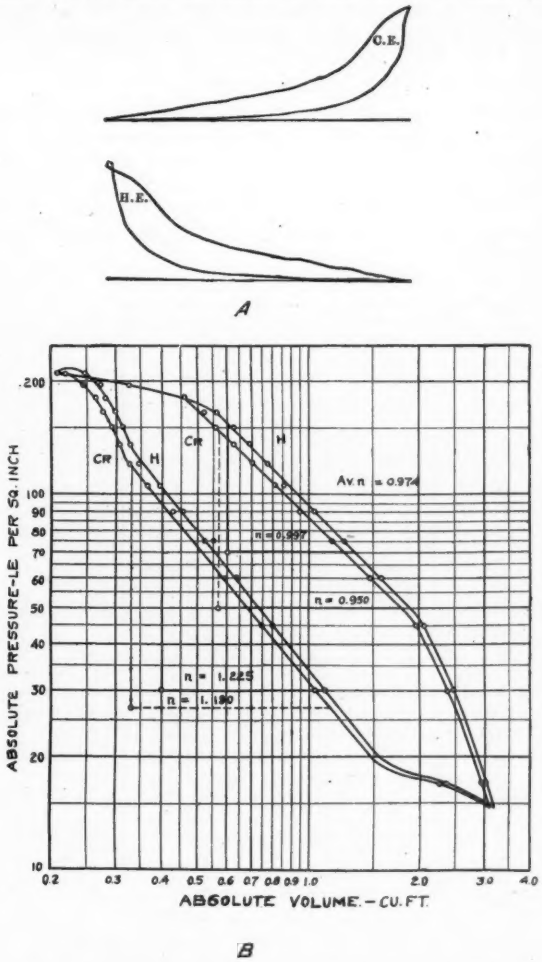


FIG. 7. A, DIAGRAMS FROM THE 16 BY 24-IN. LOCOMOTIVE AT PURDUE UNIVERSITY, USING SUPERHEATED STEAM. B, LOGARITHMIC DIAGRAM SHOWING LOCATION OF EVENTS OF STROKE

The second case, shown in Fig. 9, is from a 14 by 35-in. Corliss engine, the knowledge of the leaky condition of the piston and valves coming from the engineer in charge.

Expansion and compression lines indicate by their form at the upper ends, a large leak from the cylinder, or through the exhaust valve. The lines also show, by

the rising of the curves at the lower ends, a considerable addition to the steam in the cylinder during expansion and compression. This steam could come only from a large leak in the steam valve. Seven other diagrams taken from this same engine all showed the effect of leakage in a similar manner.

The third case of known leakage, shown in Fig. 10, is from an 11¼-in. by 22-in. double-acting ammonia compressor. This cylinder was known to be in very bad condition as to wear and leakage of piston and valves. The re-expansion curves, by the enormous amount of re-expansion shown, indicate large leakage into the cylinder during this operation. The lower part of the compression curves, by rising, indicates leakage into the cylinder, either past the piston or through the discharge valves. The upper part of these curves indicates leakage from the cylinder, either past the piston or through the suction valves.

These 3 examples show abnormal conditions which are comparatively rare. Very smooth curves may be obtained in the PV diagram, even if there is large leakage taking place. Leakage which occurs during admission or during exhaust has no effect upon the lines of the diagram as the weight of the medium is continually changing.

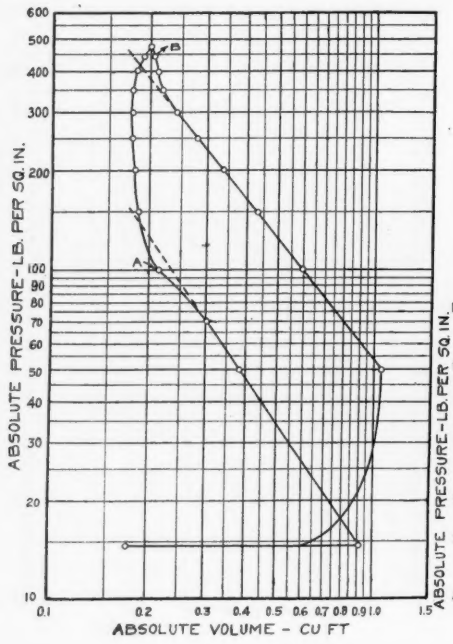


FIG. 8. LOGARITHMIC DIAGRAM FROM 10 BY 19-IN. GAS ENGINE ON ILLUMINATING GAS, LEAKAGE HEAVY AT END OF COMPRESSION AND BEGINNING OF EXPANSION

When leakage occurs in a cylinder, it is seldom found that only one source of leakage exists. Leakage is usually the result of wear, which affects most of the possible sources of leakage in about an equal proportion. As a result, several leaks are generally affecting the curves. This is the case in Fig. 9. In Fig. 9 leakage was taking place both into and out from the cylinders.

In discussing leakage, it must be kept in mind that difference in pressure between 2 regions is the cause of this phenomenon. In the steam engine, there are 3 pressures which must be considered, i. e., the pressure in the steam chest, in the cylinder at the point discussed, and in the exhaust passage. Leakage, being due to difference of pressure, becomes material only when this difference becomes considerable.

Leakage into, or out from a steam cylinder has been found to occur in most cases only when the pressure difference is over about 20 lb. In Fig. 9, the leakage into the cylinder, shown by the lower parts of the lines, begins to occur at about 25 lb. absolute, or 35 lb. lower than the pressure at admission. Leakage out from the cylinder, shown by the upper parts of the lines, ceases to occur at a pressure of about 40 lb. absolute for the expansion curve, and begins to occur at about 25 lb. absolute for the compression curve. The difference of pressure between the steam in the cylinder and that in the exhaust passage is about 35 lb. in the first case, and about 20 lb. in the second case.

This fact, founded on many diagrams analyzed, enables us to divide the expansion and compression lines roughly into 3 equal parts on the logarithmic diagram (when these lines extend from the initial pressure nearly to the back pressure): the upper third, influenced by leaks out from the cylinder; the middle third, practically uninfluenced by leakage; the third lower, influenced by leakage into the cylinder. Thus fairly reliable values of n, free from the effect of leakage, may be obtained from the middle third of the lines.

Returning to Fig. 9, both the lines indicate leaks out from the cylinder. This can occur either past the piston or through the exhaust valves. The piston generally becomes leaky sooner than Corliss exhaust valves, and, in this particular engine, one of the piston rings was found to be broken upon examination. When diagrams from both ends of the cylinder are available, piston leakage causes nearly an equal effect on the expansion curves

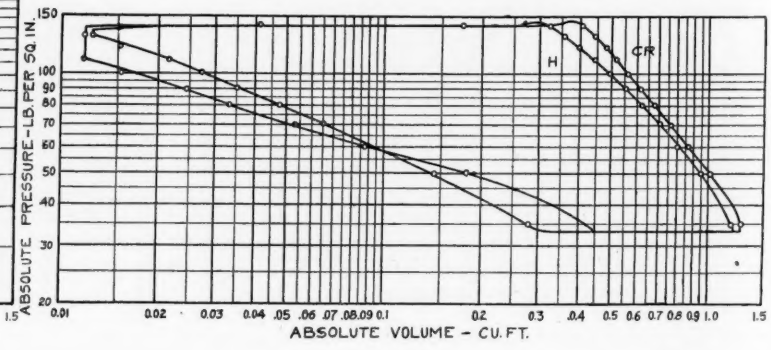


FIG. 10. DIAGRAM FROM A LEAKY AMMONIA COMPRESSOR

of both ends. The leakage into the cylinder can come from only one source which can influence the curves, i. e., the steam chest. The effect of this leak is seen in both lines in the lower thirds.

In Fig. 10 both forms of leakage are shown in the ammonia compression curves. The lower thirds show leakage into the cylinder, either through the discharge valves or past the piston. The upper thirds of the lines show large leakage from the cylinder, caused by the condition of either the suction valves or the piston. Ordinarily, it is not possible to distinguish between 2 leaks occurring in the same third of the curves.

Volume Which Leaked

FIGURE 8 is an example where only one kind of leakage is present. Here, the piston alone leaked badly at the commencement of the stroke. The effect of this leak is seen in the upper third of both lines.

When only one kind of leakage exists it is possible to compute with fair accuracy the volume of leakage taking place during expansion or compression. The lines are extended, as shown in Fig. 8, giving the lines of constant weights of the medium. The volume of gas that had leaked during compression, up to 100 lb. absolute pressure, is then seen to be 0.014 cu. ft., or 6.3 per cent of the volume remaining. The volume of gas, measured at the pressure of 450 lb. absolute, that leaked after combustion during expansion, is seen to be 0.032 cu. ft., or 18.7 per cent of the volume remaining after the leakage stopped.

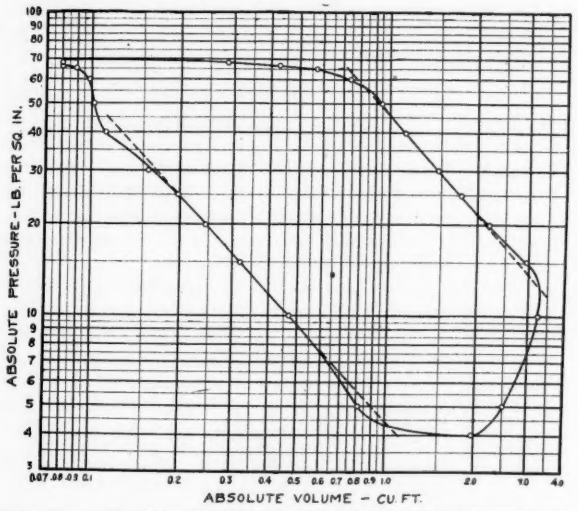


FIG. 9. DIAGRAM FROM 14 BY 35-IN. CORLISS ENGINE, SHOWING LEAKAGE AT BEGINNING AND END OF EXPANSION AND COMPRESSION

The important result that is attained by this method is not, however, the approximation of leakage, but the knowledge that it is taking place, so that it can be located and stopped.

All of our present knowledge of leakage is an inference drawn from the leakage "standing." Nobody knows whether an engine that is tight "standing" leaks when in operation, or vice versa.

Most leakage is the result of wear and tear due to long and hard use. After the wear and tear has become marked, it is the custom to rebore the cylinder and to resurface the valves and valve-seats.

It is apparent that the existing methods of determining when general repairs are necessary are in a very haphazard state as regards economy, and that the personal judgment of the man making the decision may be liable to great variation.

The method of detecting leakage from the logarithmic diagram offers a more rational solution of this important question.

Studying the Logarithmic Diagram

IN the discussion upon the effect of wrong clearance, leakage, and excessive condensation upon the lines of the logarithmic diagram, it was assumed, for the sake of clearness, that only one of these effects existed at one time. The examples were selected so as to illustrate only one of these effects in each case.

Cases occur where several of these effects exist at one time in the same diagram. The separation of one effect from another is not an exact process. However, the character of the curves showing excessive condensation, wrong clearance, and leakage are quite different. For instance, wrong clearance affects the lines throughout their length. Excessive condensation, in the cases of the steam diagrams examined, always affects only the upper parts of the curves. Leakage, as has been mentioned, affects materially only the upper and lower thirds of the lines, where these lines extend from the initial pressure to nearly the back pressure. When excessive condensation and large leakage exist together, no close approximation of the clearance can be made.

NATURAL VACUUM CLEANER

By W. A. Jones

I SEE many makes of vacuum cleaners described by readers of Practical Engineer and I am sending a scheme of my own, but any engineer or fireman can use it, that is, if they use it often enough so the neighbors won't kick.

Take 2 old 1¼-in. gate valves and make a connection on top of the boiler to the breeching as shown and get a light 1¼-in. hose long enough to reach

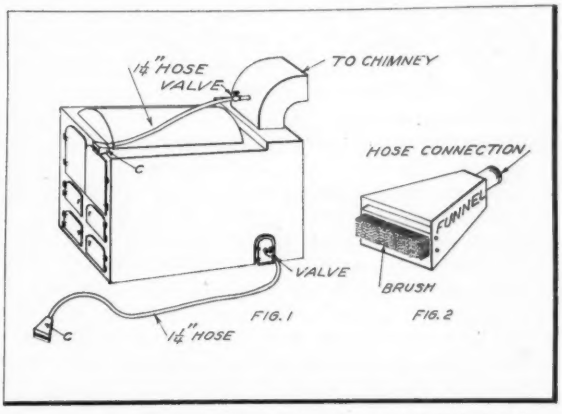


FIG. 1. METHOD OF ATTACHING VACUUM HOSE
FIG. 2. DUST COLLECTOR FOR CLEANER

the farthest dusty place on the boiler, connect the hose on the breeching, and then put on the dust collector as shown at C.

Figure 2 shows how to make the dust collector, only a funnel with a long haired bush fixed in the end with the hair extending from the end so as to sweep or loosen the dust. Follow these instructions and you will be surprised to see the dust disappear. Put the hose on the clean-out door using the second valve, for cleaning the pumps and pipes on the floor, etc.

THE SAVING IN "frictional losses" cannot be too strongly impressed upon a manufacturer. The cutting down of shafting means a saving in first cost of the factory, a saving in labor and oil and adds much to the appearance of the factory. In illustration: The friction horsepower in a prominent factory amounted to 135 hp. The cost of fuel to supply such a friction load alone was an item completely overlooked by the manufacturer. After investing heavily in his present layout of shafting the trouble was discovered, all of which could have been avoided by a realization that friction losses must be reckoned with.—The Canadian Manufacturer.

PURCHASING THE BOILER*

Specifications for One Horizontal Return Tubular Boiler, for 125 lb. Pressure, Extension Front, Suspension Setting

By Hubert E. Collins

A COMBUSTION chamber arch is to be furnished. ———— manufacture.

This boiler is to have one full set of ———— shaking grates with bearing bars of the following dimensions: 72 in. wide, 72 in. deep and ⅜-in. air space. These grates must be set up so as to insure against warping of bearing bars, and the air space must be equal all around and between sections. These grates must be set in 2 sections wide. All grates must be free from casting flaws.

Fusible Plug, Dry Pipe and Smoke Box

A 2-in. fusible plug with Banca tin filling is to be placed in rear head about 2 in. above top row of tubes.

Connected with main steam outlet on rear course, is to be one internal dry pipe of efficient design. This pipe must be dripped and secured against vibration.

The main shell shall be extended 18 in. to form part of the smoke box. The top third of the circumference shall be cut away, and to this shall be bolted a ⅜-in. plate having a smoke nozzle riveted thereto. This nozzle must be 5 ft. by 1 ft. 4 in. dimensions, and must be fitted air tight all around and contain a carefully fitted counter-weighted, heavy steel damper with an adjustable arm.

Fittings

THIS boiler is to be furnished with: 1. One high pressure ———— water column complete with heavy pattern finished brass water gage fittings and ¾ in. by 18 in. glass, and some approved type try cocks. The water gage fittings must be quick closing type with operating chains. With this column must be furnished all pipe and valves for connecting up. The pipe and valves are to be of extra heavy brass. The steam connection must be taken from a reenforced opening on top of shell with a globe valve close to boiler, the water connection to be taken from the front with a globe valve just outside of the smoke box. The water column must have a connection below with a stop valve and pipe leading down and into the ash pit for blowing down the column. The column must be set up with a brass ground joint union immediately above and below it so that it can easily be removed at any time. The steam and water connections are to be 1¼ in. pipe size, and the blow pipe ¾ in.

2. Extra heavy brass feed pipe fittings and valves 1½ in. pipe size. This feed line must be carried from boiler front outside the smoke box and down to about 5 ft. from floor line where it will turn horizontally and with shoulder nipples intervening, will be placed in succession, a globe valve, union, a check valve union, and globe valve. The unions to be brass ground joint.

3. One (1) extra heavy semi-steel Y, flanged, faced and drilled and furnished with bolts and hexagonal nuts with copper gaskets to secure it to front nozzle and bolt thereto 2 safety valves hereafter specified.

4. Two (2) 3½-in. flanged, faced, and drilled pop safety valves set to blow off at 100 lb. pressure. These valves to be of ———— make, nickel seats, lock up pattern.

5. One (1) 10-in. face, iron case, brass ring steam gage of ———— make. The face is to be lettered as ordered. The gage is to be fastened to front just over flue in center and connected with brass pipe and fittings into the steam line to water column at some point inside stop valve on that line. This steam line to gage is to have a stop valve near its supply and a condensing coil and pet cock near the gage.

6. One (1) set of fire tools, 8 ft. 6 in. long consisting of hoe, slice bar and rake with D handles.

7. One (1) ———— injector tube cleaner (3 in.) with 50 ft. of steam hose.

Inspection and Testing

A REPRESENTATIVE of the office of the engineer will make one inspection when shell plates have been cut, planed, rolled, punched and bolted together for reaming; at this time he will witness tensile, cold and quench tests of material while reaming of rivet holes is going on and will see plates taken apart for cleaning and removal of burrs, etc. A second trip will be made when boiler is completed and witness hydrostatic test of ⅓ more pressure than s.w.p. herein stated. The boiler must be tight under this test.

The bidder is to allow traveling and hotel expenses for these 2 trips from ———— to the works. Due notice must be given the office of the engineer, so that he may be at the works on time and not be delayed beyond the necessary time for inspection. Any unnecessary time, owing to delay on contractor's part, or time for any extra trips made necessary by defective material or workmanship, will be charged to the contractor at the rate of ———— per day.

Suspension Work and Setting

THE contractor is to furnish one complete set of suspension work for this boiler, to consist of four (4) cast-iron columns with proper base and top for the securing of I beams, four (4) I beams each of 18 lb. per ft., 8 in. depth, four (4) suspension rods, bolts and plates, all bolts, nuts and washers necessary to fasten the whole together.

The cast-iron columns are to set outside of walls of brick work, and this contractor is to furnish complete one setting as herein generally specified. The footing for walls and columns must be of a good grade concrete mixed 6 parts broken stone, 3 parts clean sand, and 1 part best Portland cement. The footing of this material must be 18 in. thick, and the top of it 6 in. below floor level. It must be put in one block to take in 2 in. back of rear wall, side walls, and 2 rear columns, floor of combustion chamber up to a line with front of bridge wall, from there 2 lines will extend from inside of fire pit wide enough to take in front columns and side walls to a line 2 in. further than front line of side walls. The side and rear walls are to be 20 in. thick without air space all around. The front arches and jamb and rear arch are already specified of ———— moulded ———— and in addition, the side walls are to be lined back to a line with the front of bridge wall with ———— moulded blocks set in fire clay. The rest of setting

*Continued from page 403 of April 15th issue.

with face of bridge wall is to be lined with Maurer's best fire brick set in clay. This brick lining is to be tied to the wall every fourth course. The bridge wall is to be clear of the side walls and allowance be made for expansion of bridge wall not affecting side wall. The side walls are to be closed in to boiler on a line 5 in. above center line with ample provision being made for protecting suspension straps and allowing for the suspension rods proper play. The floor of combustion chamber must be on floor level covered with hard brick set on edge with a chase for blow-off pipe extending through rear wall. Floor of ash pit must be lined with hard brick on edge set in cement, and this level will be 6 in. below floor line. Top of boiler is to be covered with arch of brick set on edge. The over-hang of boiler must be covered around its circumference with 2 in. of asbestos and with ¾ in. air space. Rear wall must be 24 in. from boiler and all other details of setting are to be standard practice of contractor after being submitted in the drawings for final approval.

Drawings, Insurance and Delivery

THE contractor receiving the order will furnish a first-class drawing of the boiler and fittings, and one of the setting complete.

This boiler is to be inspected by the Hartford or Fidelity and Casualty Company for one (1) year for the sum of $500.00 and the insurance policy with inspection and test certificates to be furnished by the builder to ————————.

This boiler and setting to be furnished erected on premises of ————————.

General

THE right is reserved to reject any and all bids.

Proposals are to state desired terms of payment.

Proposals are to state a specified time of delivery.

Proposals are to state a specified time of erection of boiler and setting complete ready for city inspection on above premises.

It will be noted that these specifications call for certain horsepower rating and states what that amounts to. To fix the height of the water line, fixes the heating surface and the steam space as well.

The percentage of the heating surface in the shell to the total is thus fixed and there cannot be a great variation in the estimated cost of material. It also fixes the capacity for the purchaser so that he will get a fair allowance of heating surface per horsepower, and no other estimated amount than herein specified will do.

As to the advantages of an overhung front, there are several arguments for and against. The principal argument for it, is a self contained front not depending on the setting alone for support.

An important specification which has a bearing on price is the manner of flanging the heads. Some are pressed hydraulically and on others the flange is turned gradually while turning the head around (spinning it) in the flanging machine. The pressed heads are more liable to be cracked or fractured in the flange fillet, but the process is cheaper to the manufacturer.

If the reader will carefully read the first paragraph under the head "Riveting" he will note one of the most important points in boiler manufacture. Some manufacturers will drill or punch rivet holes full size while the plates are flat, then roll the plates, bolt them together, and start riveting. By this process it is impossible to make all the holes come fair. The result is that some holes are "drifted" into place making a poor job of riveting and sometimes leaving fractures in the plates. This process is manifestly cheaper than the one called for in the specification. It can be seen that if the process of preparing the plates for riveting is not specified then an unscrupulous manufacturer can cheapen the process, underbid a reliable firm who would scorn to use the cheaper process, and in the end make the purchaser pay the full price, may be more for a boiler that never will be right. Punching the holes small then drilling them large, does away with the possibility of a fracture around the holes.

As for the balance of the specification, the point is to be specific in each detail and where specialties are part of the equipment, the manufacturer should be named so that every bidder will be on an equal footing.

The writer is one of many advocates of the suspension type of setting for horizontal return tubular boilers as they are more substantial and the brick setting will deteriorate much less.

Another fallacy shown is the air space in the side walls of settings. Provision should be made for the expansion of the bridge wall into the side walls in some manner as herein specified.

The inspection by the engineer is very important as it insures the specifications being complied with in the most vital points and at the right time. Then again, the engineer can become familiar first hand with the shop and process and be better able to protect his client's interests.

It is certain that a great deal of trouble in plant operation could be avoided by specific calls for bids and a thorough understanding of the reasons for each. This has been impressed on the writer more and more after numerous examinations of plants which revealed the source of trouble here. Owners should require proper specifications prepared by competent engineers, and the man who prepares them should study each case till he knows all the details of the requirements.

IN A TEST made by Geo. H. Barrus of Boston, on a 3500 kilowatt turbine unit at the Riverside Dan River Cotton Mills, at Danville, Va., an interesting method was employed to secure the steam consumption The total water evaporated was measured by a 4-in. Worthington piston meter, carefully calibrated, and from this was deducted the steam used by the condenser turbine, cloth hall and leakage.

For determining the steam consumed by the condenser turbine, the method of orifice measurement was employed. A plate ⅛ in. thick was inserted between a pair of flanges in the 4-in. supply pipe, and this plate contained 2 orifices, each 1 in. in diameter. Two gage pipes were connected to the 4-in. pipe on either side of the plate and carried down to a tee, common to both to which a steam gage was attached. The drop in pressure between the 2 sides determined the quantity of steam passing through the condenser turbine as the drop was referred to previous calibration of the orifice.

In the same manner the steam used by the cloth hall was ascertained. Leakage of the plant which embraced the boilers, steam pipes and valves attached, was made one night after the main turbine was shut down. Sufficient fire was left on the grates to maintain the steam pressure in the 6 boilers. The quantity of leakage was ascertained by observing the fall of water shown in the gage glasses, and computing the quantity which this represents from the known measurements of the boiler at the water line.

GREENE ENGINE VALVE MOTION

Description of Valve Gear and Governing of Engine, Method of Adjusting, Starting and Stopping

By Pearl E. Merriam

BEING one of the earliest automatic engines built, the Greene engine later was changed considerably in design of details and became known as the Improved Greene, a general view of the valve gear side being shown in Fig. 1. From an inspection of Fig. 1, it will be seen 2 eccentrics are employed, one to actuate the steam and the other to move the exhaust valves. All the valves are of the gridiron type to give large port opening with short valve travel.

Figures 2 and 3 are longitudinal and cross-sectional views of the cylinder. The eccentric nearest the flywheel is the steam eccentric from which an eccentric rod transmits motion to the rocker or carrier arm. To this rocker arm the hook rod is connected and the other end of this rod engages a stud on the sliding table, A Fig. 4, and is not adjustable.

The sliding table has 2 recesses in it through which the tappets B and B¹, Fig. 4, are raised or lowered by the governor. The length of the steam valve stems are fixed, one end is held in the crosshead A, Fig. 2, and a head on the valve stem fits in a slot on the steam valve B. On the rock shaft E is mounted an arm D, which, at the outer end, fits over a pin C fastened in a block free to move vertically in a slot in crosshead A. Rotation of the shaft E therefore operates the steam valves B. This rock shaft is supported by the bracket H, Fig. 3, and derives its motion through the toes J, Fig. 4. On the outer end of each rockshaft is a pocket containing the toes J, which are free to drop by gravity in these pockets. The pockets are supported by the cranks F, mounted on the rockshafts. Between the cylinder and the rockshaft bearing F, Fig. 3, the dash-pot rod L, is secured to the rockshaft. The steam valves open, moving toward the end of the cylinder, consequently the eccentric follows the crank.

The exhaust eccentric A, Fig. 6, has a semi-circular yoke B, supported by a stud H, on each side. A large opening in this yoke at the bottom contains a sort of toggle joint that imparts motion to the crank C, keyed to the exhaust rockshaft D. This shaft D is supported in bearings E, and runs parallel with the frame to a point a little in front of the cylinder, where a clutch is mounted to allow the exhaust valves to be disconnected from the exhaust eccentric when handling the engine with the bar.

On this exhaust rockshaft are 2 cranks, D, Fig. 3, which are connected by the link C, to the small crosshead B. The exhaust valve stem A is keyed to the crosshead at one end and engages a slot in the valve at the other end, thus giving movement to each exhaust valve. The governor, Fig. 5, is of the high speed counter weighted type and controls the elevation of the tappets, B, B¹, in the table, Fig. 4, which, by their height above the table, causes the toes J, J, to engage with the tappets for a longer or shorter time as the toes swing in an arc, while the table moves in a straight line under them. On the steam valve crosshead slide a mark A¹, Fig. 2, is seen and when the edge of the crosshead is in line with the mark the steam valve is ready to open the port. By removing the steam chest cover the edge of the steam port and valve can be seen and the mark A¹ varified. The only way to change the lap on the steam valves is by the length of the dashpot rods.

Exhaust valves move toward the cylinder to open. On the guide for the exhaust valve crosshead B, Fig. 3, is a mark G. When the edge of the crosshead and the mark are in line, the exhaust valves are at the point of opening or are line and line. To varify the mark G, a piece of paper is inserted between the valve

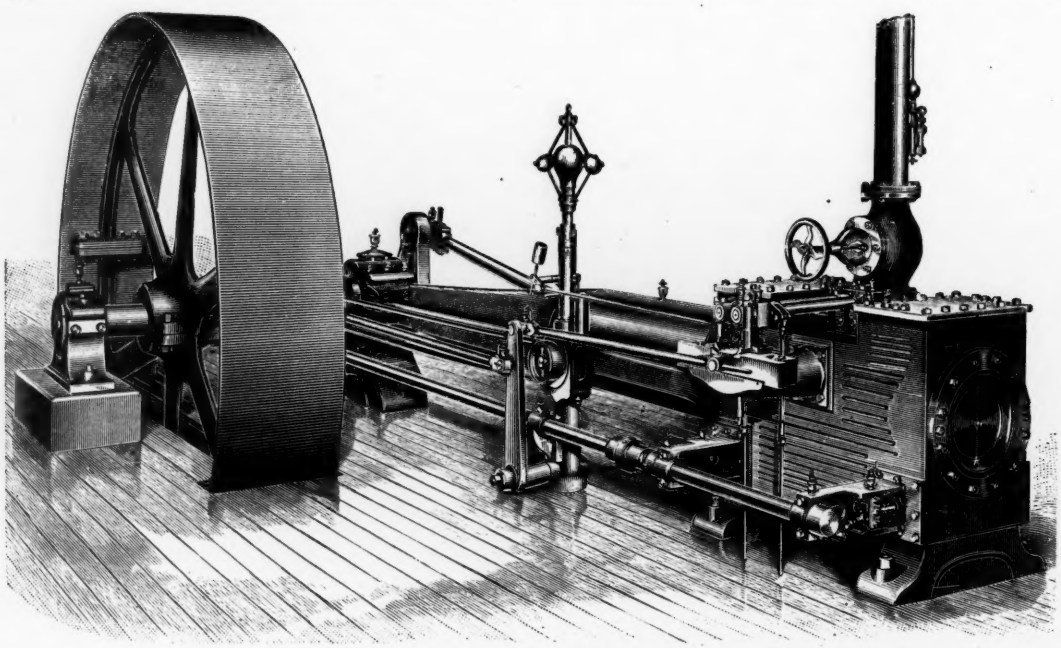


FIG. 1. IMPROVED GREENE ENGINE WITH FOUR VALVES AND AUTOMATIC CUTOFF

and the edge of the port. To change the lap on the exhaust valves, adjust the right-and-lefts between the crank D, and the crosshead B.

As usual with 4-valve releasing gear engines advancing the steam eccentric will give more lead and earlier cutoff, while moving the steam eccentric backward has the opposite effect. Should the eccentic rod be too long the lead will be greater on the head end and cutoff earlier at the same time the lead on the crank end will be less and cutoff later.

Valve Adjustment

ASSUMING that the crank is to run over, valve adjustment may be done as follows: Place the crank on the head end dead center. Then turn the steam eccentric from one dead center to the other and so adjust the eccentric rod that the rocker-arm will travel equally on each side of its vertical center line. Then turn the solid part of the slotted safety collar 1, Fig. 5, on the governor so that the solid part will support the governor, giving the longest travel to the steam valves without tripping them. So adjust the length of the dashpot rods L, Fig. 3, that the pockets C, Fig.

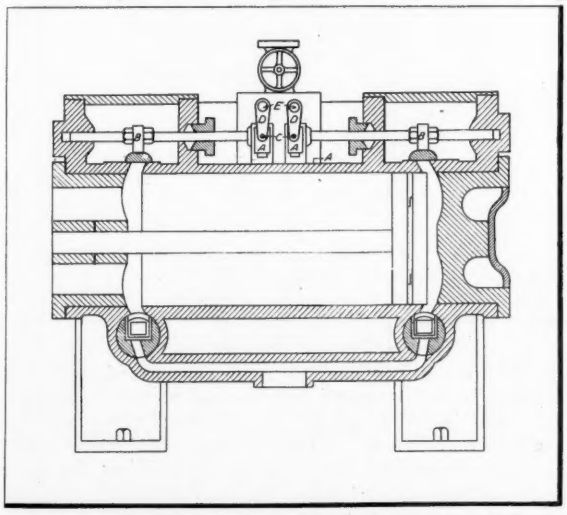


FIG. 2. LONGITUDINAL SECTION OF GREENE ENGINE CYLINDER

4, will be square with the sliding table A, when the dashpots are seated.

The steam valves should now lap on each side of the steam port, the steam lap being measured from the inner edge of the steam port toward the cylinder to the inner edge of the steam valve. About the same lap should be given these valves as those on other releasing gear engines, with the same size cylinder. See that the toes J J hang low enough to engage with the tappets B B, Fig. 4, if not, lower them being sure that the blocks on each are in good condition.

Roll the steam eccentric around the shaft and observe if when the sliding table is at one extreme of travel the steam port at that end is opened the same as that at the other when the sliding table is at its opposite extreme, if not, adjust the length of the dashpot rods until they are opened an equal amount.

The steam eccentric should be turned on the shaft in a direction opposite to that in which the crank is to turn until the proper lead is obtained at the head end steam valve, generally about 1/16 in. Secure the eccentric, turn the engine over in the direction of rotation to the other dead center and see if the same lead is obtained on the crank steam valve, if not, change the length of eccentric rod. After another trial on the head end dead center, if the leads show differently, move the eccentric slightly on the shaft. Be sure that the toes and tappets have a good bite at each extreme of the travel of the sliding table.

With the exhaust eccentric A, Fig. 6, loose on the shaft revolve it from one extreme of travel to the other and see if the crank C is moved equally above and below a horizontal line passing through the center of the rockshaft D, if not, and much wear has been taken up at the toggle joint, a sheet metal shim may be used to throw the travel as required to meet this condition, or the exhaust eccentric may be moved on

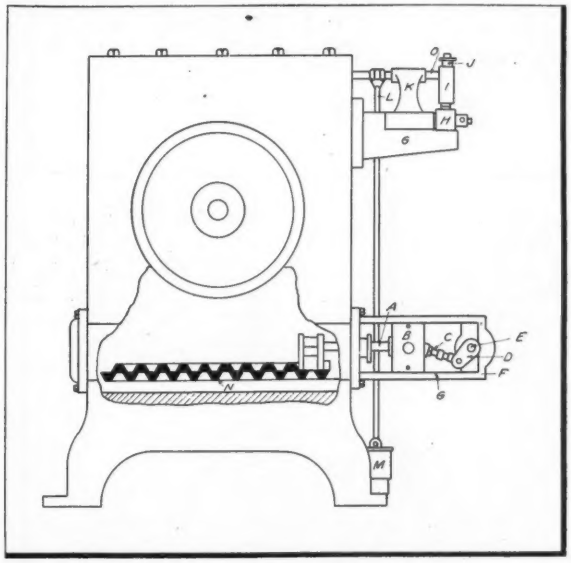


FIG. 3. CROSS-SECTION OF GREENE CYLINDER AND VALVE

the shaft toward the main bearing to cause the crank C to swing lower. When the eccentric is moved toward the flywheel the crank C will travel higher than the rockshaft center. After the position of the exhaust eccentric has been determined horizontally on the shaft it should not be moved.

On the guide F, Fig. 3, is a mark G. When the edge of the crosshead B is in line with this mark the exhaust valve and port should be line and line. Turn the exhaust eccentric on the shaft until the crosshead B is at its extreme of travel away from the cylinder or into the position that represents the closed position of the exhaust valves. Measure from the edge of the crosshead to mark G on the guide and if it is 0.25 in. the exhaust valve has the right lap. If this measurement is not obtained change the right-and-left connection C, until it is secured. Adjust the same for the other end.

Turn the engine over until the piston has traveled on the return stroke to the position where it is desirous to have compression begin. Turn the exhaust eccentric ahead until the crosshead B comes in line with the mark G on the guide F, which will indicate the closing of the exhaust valve, then secure the eccentric. Turn engine over until the piston has completed the same distance of travel approaching the other end of the cylinder and see if the exhaust valve closes the exhaust port at this time, if not adjust the right-and-left link C until it does. If the release is considered faulty change the exhaust lap, and to give more compression advance the exhaust eccentric.

Governor

OWING to the angularity of the connecting rod the piston travels slower from the crank end than from the head end and the cutoff will be later on the head end with a higher initial pressure in the crank end. Equal cutoff should be given at each end, there-

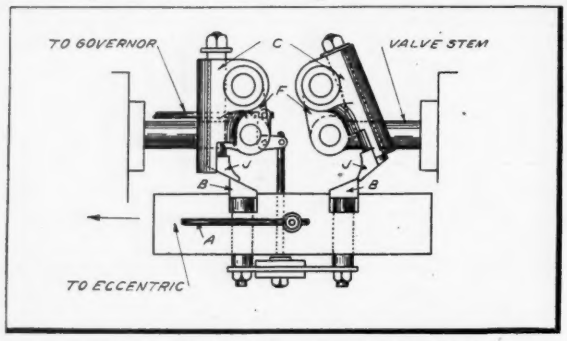


FIG. 4. DETAILS OF TAPPET AND TOES

fore, we arrange the toe on the crank end to drop lower than the toe on the head end by means of the nut and lock nut at the upper end. The toe on head end being 1/32 in. shorter or higher in the pocket. The

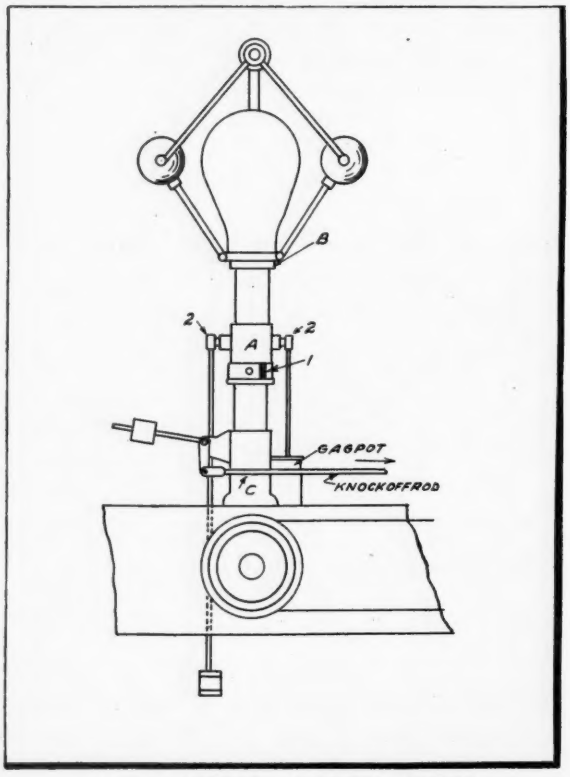


FIG. 5. GOVERNOR OF GREENE ENGINE

tappets should rise an equal distance above the sliding table with the governor on the safety collar, so adjust the position of the toes that they engage the tappets for the full travel of the sliding table. Then block the governor up to its highest plane and be sure that toes and tappets do not engage thereby cutting off the steam supply from the cylinder. Should they engage at this time change the height so that they will not hook on. Block the governor into the running position and turn the engine over slowly, raising or lowering the toes until the cutoff is equalized.

Operation of the safety stop is as follows: The reach rod from the governor connects with a rockshaft and a crank is secured to the other end of this shaft. At the other end of this crank a small crank is connected and the knock-off rod from the toes is connected to this. Beneath the governor knock-off rod on the column is a pin. During ordinary running conditions the small crank to which the knock-off rod is connected and the crank on the rockshaft are in line and operate as though they were one solid piece changing the cutoff by elevating or depressing the tappets.

Should the governor belt become disabled and unable to drive the governor, the governor balls will drop. The collar A drops with the side projection 2, 2, Fig. 5, passing into the slots in the safety collar, which brings the knock-off rod into contact with the pin C and prevents it moving lower. The small crank

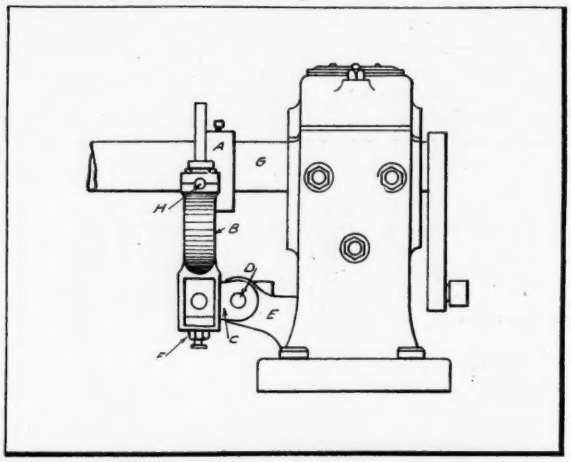


FIG. 6. DETAILS OF EXHAUST MOTION

referred to will continue to move downward with the governor and be moved from its dead center, imparting to the knock-off rod an additional travel throwing the knock-off rod in the direction shown, preventing the toes from engaging the tappets, by holding the tappets lower above the sliding table. Should the tappets and toes by any manner engage with governor in lowest position lower the tappets. Use the indicator for final adjustment.

Handling Engine

SOME of these engines have a socket provided at the top of the pockets C C, Fig. 4, for the insertion of a starting bar, to be changed from valve to valve as required. On others one of the accompanying wrenches fits on a shoulder on the rockshaft to be used to operate the steam valves. Mention has been made of the clutch between the exhaust eccentric and the cylinder whereby the exhaust valves may be thrown out of engagement with the exhaust eccentric and moved by hand. By inserting the bar in the hole provided for it in the clutch the exhaust valves may be disengaged for the eccentric, the usual method of stopping the engine being to plug or block the piston with exhaust valves when engine is running very slow.

To Start Engine

WITH the governor resting on the safety collar after the cylinder has been warmed up by blowing steam through it put in the clutch and move one of the steam valves if need be with the bar, then open the throttle. After full speed is attained move the safety collar to such a position that the governor can drop to lowest position.

A LOW STEAM RECORD

New Design of Corliss Nondetaching Valve Shows Consistent Low Results for Steam Used. Details of the Valve Action

AMONG THE FACTORS RECOGNIZED as contributing largely to the success or failure of the economy of a steam engine are quick-action valves, small leakage, low clearance space, high piston speed. Designers of engines usually depend on putting valves in the head in order to cut down leakage, on using a good amount of lap to prevent leakage past the valves, and some form of the Corliss wristplate motion is used to give quick action while the valve is moving and rest when the valve is closed. In the

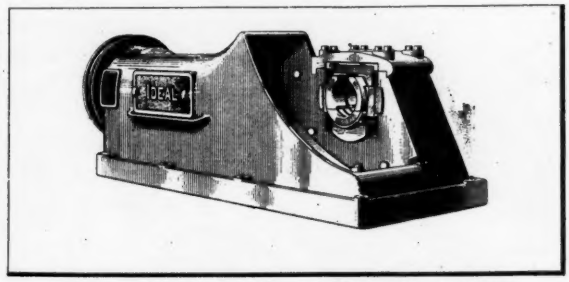


FIG. 1. MAIN FRAME OF THE IDEAL ENGINE

detachable Corliss valve, the period of rest is obtained by disconnecting the valve from the driving mechanism, but in the nondetaching gear this period of rest is obtained by a special arrangement of linkage, the details differing with each design.

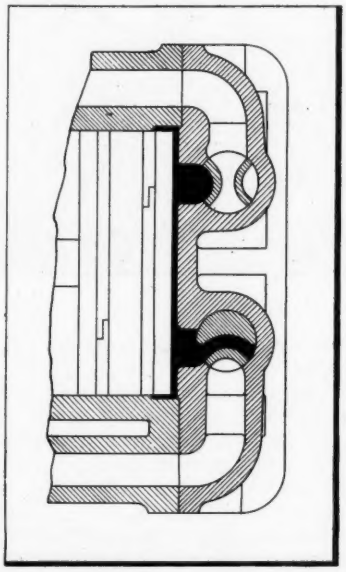


FIG. 5. SECTION THROUGH CYLINDER HEAD AND VALVES OF CORLISS NONDETACHING 4-VALVE ENGINE, SHOWING LOW CLEARANCE SPACE IN BLACK

In the New Ideal Corliss Valve Engine, manufacted by A. L. Ide & Sons of Springfield, Ill., the features above mentioned have been incorporated, and the results hereafter given show that their use has produced results.

The engine has many striking features and it is worth while to take these up somewhat in detail.

Main Frame

IN this part of the engine, strength and rigidity are of prime importance, and these are secured by a cross section of great depth with the housing carried entirely around the main bearing. This takes care of the strain due to the bending movement from the overhanging crank. In order to reduce this amount as much as possible, the main shaft bearing is extended well over toward the center line of the engine,

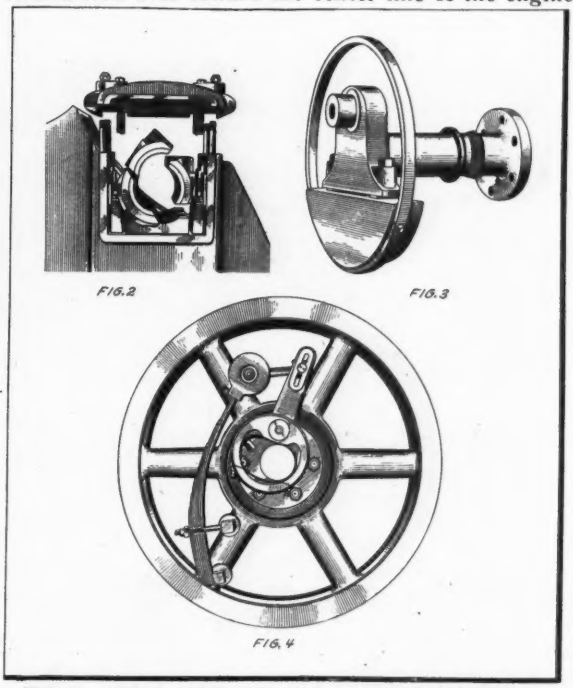


FIG. 2. IDEAL MAIN BEARING SHOWING METHOD OF REMOVING BOTTOM SHELL

FIG. 3. CRANK AND ONE END OF THE COMPLETE SHAFT

FIG. 4. ARMSTRONG CENTRIFUGAL GOVERNOR AS USED ON IDEAL ENGINES

thus giving small overhang, and bringing the thrust on the connecting rod close to the bearing. This overhang is also reduced by making the crank shaft of a single piece of steel, thus reducing the thickness of crank arm necessary.

Main Shaft

THIS is of the coupled type, having a flange beyond the main bearing which is bolted to a companion flange on the extension of the shaft, this extension being for the reception of belt pulley, generator armature, or rotor of a centrifugal pump. Opposite the crank is a counterweight bolted on, and having on the back side a tapped hole into which a gage is screwed. By turning the crank the gage can be brought opposite 3 faced-off bosses which are cast on the inside of the frame at the crank end, and the distance can be measured between the gage or pointer and the bosses, thus testing up the alinement of the engine at any time.

Main Bearing

THIS has movable shells, the bottom shell being fitted in a circular seat, first to fit the alinement of the shaft, and second to permit the bottom shell to be removed by rolling it around the shaft without dismantling the engine or requiring the shaft to be jacked up any considerable height. The bearing is contained in the housing in the main frame and besides the bottom shell has 2 quarter boxes or slide shells with separate wedges to permit of side adjustment for wear. The whole is held in place by a cap and is kept submerged in oil.

To regulate the speed of the engine closely the Armstrong type of governor is used in which the weight is mounted directly on the end of the leaf spring so that the only force required to be transmitted through the governor is the small one necessary to drive the valve. The governor is mounted in the flywheel which has heavy spokes with bosses cast for this purpose, and the hub of the flywheel is cased to receive the solid flanges of the coupled shafts, the bolts being carried through both flanges and the flywheel hub.

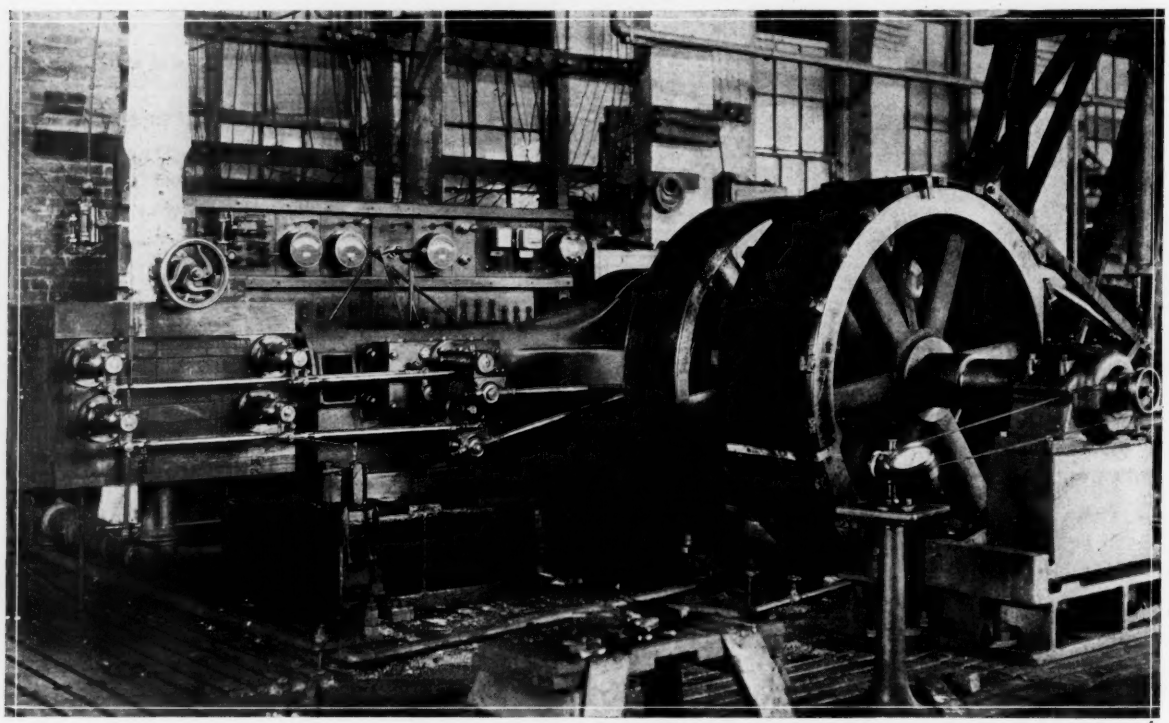


FIG. 6. 16 BY 22-IN. IDEAL CORLISS ENGINE ON TEST FLOOR

Valves and Valve Gear

THE valves used are of the Corliss rotating type, multiported and unbalanced when closed, but balanced when in the open position. This means that after they have moved the amount of the lap they become balanced valves during the rest of their motion. These valves are placed in the cylinder heads as shown in Fig. 5, thus reducing port clearance and the consequent steam loss.

Each valve is driven by a T-head and crank as indicated in Fig. 6. The exhaust valves are driven from a wrist plate by an exhaust eccentric and the regular Corliss exhaust valve action, while the steam valves are driven by a link motion having an accelerating gear which gives rapid opening and closing but allows the valves to remain at rest during their closed period. This linkage is enclosed in a case containing oil so that all bearings are at all times submerged, leaving the only parts of the mechanism showing outside of the valve box a crank connection to the eccentric rod and 2 cranks with straight reach rods running from the gear box to the valve cranks.

Studying now the motion drawing Fig. 7, which represents the action of the eccentric, accelerating gear and valve rod, valve crank and valve, but does not show the exact mechanism, we will study the action for the head end valve. The eccentric E travels around its circle and drives the eccentric rod which connects to the wrist plate pin W. seen in Fig. 6 as a hanging crank on the outside of the gear case. Inside the gear case is a rocking plate with 2 arms, A and A^1, for the driving head and crank end valve linkages. From the arm A, a link runs to the fulcrum B, all joints being pin joints. This fulcrum is mounted on a sliding rod which passes through a pivot C, the rod R being free to slide back and forth through C. From the fulcrum B, a link runs to the valve crank D, which gives motion directly to the valve stem.

The different positions of the various points are numbered correspondingly. Starting at the position 1, as the eccentric moves up to position 3, the arm A moves from its position 1 to 3, and the link of B is forced to the left up to its position 3, shoving the rod R through the stud C. This motion is accomplished by swinging about the center D so that the valve crank is not moved during this period.

As the eccentric advances from 3 to 5, point W travels from 3 to 5 on its arc, and point A upward from 3 to 5, the point B being drawn to the right and the rod R sliding to the right through stud C, as

point B advances from point 3 on its curve to point 5 on its curve. This forces the valve crank upward from its position 3 to 5, and the valve is swung over by the amount of its lap, bringing it to the point of admission. As the eccentric travels on from 5 to 6,

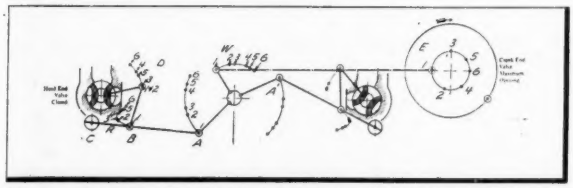


FIG. 7. MOTION DIAGRAM OF STEAM VALVE ACCELERATING MOTION

the points W, A, B, and D, make the corresponding travel and open valve for the admission of steam. As the eccentric swings from 6 to 4, point W travels back from 6 to 4 on its arc, and points A, B, and D, make corresponding motions, bringing the valve back to the point of cutoff, and in going from 4 to 2 the eccentric swings all parts of the mechanism through corresponding arcs, bringing the valve back to its closed position. By following a repeated action it will be seen that while E moves from 2 on the eccentric is at rest it is unbalanced, that is, the steam pressure tends to force it against the seat while from the time that the ports begin to admit steam until the valve

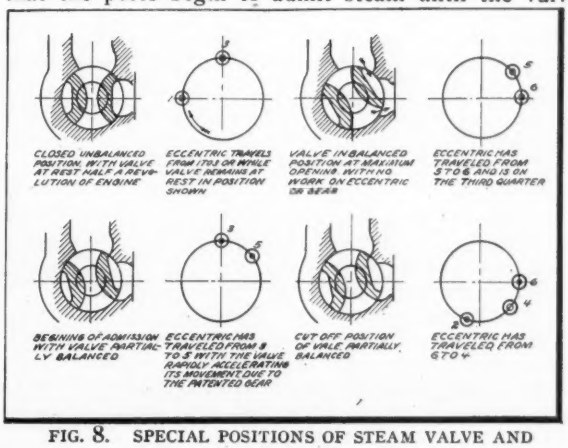

CLOSED UNBALANCED POSITION WITH VALVE AT REST HALF A REVOLUTION OF ENGINE
ECCENTRIC TRAVELS FROM 1 TO 3 OR WHILE VALVE REMAINS AT REST IN POSITION SHOWN
VALVE IN BALANCED POSITION AT MAXIMUM OPENING WITH NO WORK ON ECCENTRIC OR GEAR
ECCENTRIC HAS TRAVELED FROM 5 TO 6 AND IS ON THE THIRD QUARTER
BEGINNING OF ADMISSION WITH VALVE PARTIALLY BALANCED
ECCENTRIC HAS TRAVELED FROM 3 TO 5 WITH THE VALVE RAPIDLY ACCELERATING ITS MOVEMENT DUE TO THE PATENTED GEAR
CUT OFF POSITION OF VALVE PARTIALLY BALANCED
ECCENTRIC HAS TRAVELED FROM 6 TO 4

FIG. 8. SPECIAL POSITIONS OF STEAM VALVE AND ECCENTRIC

cuts off the steam pressure is balanced on the 2 sides of the valve.

High speed of the valve during opening and clos-

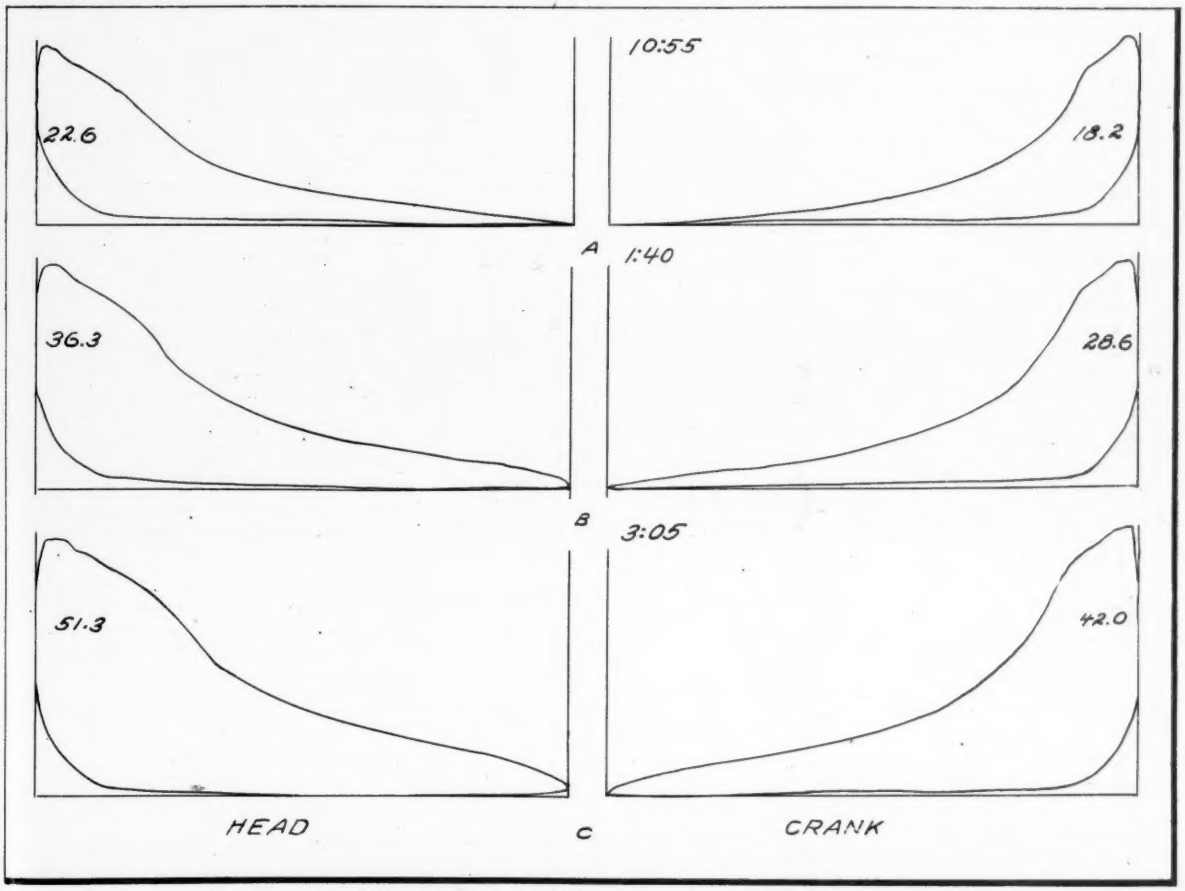


FIG. 9A. INDICATOR DIAGRAMS FROM TESTS AT 150 LB. STEAM CHEST PRESSURE

circle to the point 3 the head end admission valve stands still. The same action can be followed in the case of the crank end valve if desired.

Figure 8 shows the valve in the positions indicated and the corresponding eccentric position, and it will be noticed that during the period while the valve ing is obtained from the fact that during this time the eccentric is on the quarters and is giving the maximum speed to the eccentric rod and connecting gear, and has the maximum moment to move the valves at the time when they call for the greatest amount of driving power.

Economy Tests

PROOF of the successful design of a machine is always its successful operation, and in the case of this engine several series of tests are available which show conclusively what the engine is doing. From these, 2 are taken for discussion. The first series was made with steam at 125 lb. pressure at the throttle and with zero pressure on the exhaust. The engine ran at 200 r.p.m. with dry and saturated steam, the steam from the exhaust being condensed in a surface condenser which had an outlet to the atmosphere, holding the atmospheric pressure in the condenser.

Condensed steam was pumped from this condenser to weighing tanks and carefully weighed at the end of each 5 minutes to be sure that there was no serious irregularity in the operation of the engine. All drip and waste was carefully collected and weighed. Cards were taken by an indicator at each end of the cylinder the springs being carefully calibrated before and after the tests, and load was supplied by means of a water-cooled prony brake, and the power held constant by a man stationed at the brake to regulate the tension applied.

Before each test of a series, the engine was allowed to run for from 15 to 20 min. to get warmed up and adjusted to the load which it would carry. The arm of the brake worked against a coil spring contained in a cylinder, and the position of the arm was noted by a long multiplying pointer playing over a scale. The tension on the brake band was adjusted by the attendant so that this pointer remained always at the same position, thus giving the same amount of pull against the opposing spring at all times. The steam gage was attached to the steam pipe and the thermometer inserted into the steam chest directly at the engine, and the pressure was held as nearly constant as possible throughout each test.

FIG. 10. TABLE OF RESULTS OF ENGINE TESTS

TEST	A	B	C	D	E
DURATION	10:45-11:45	1:10-2:10	2:40-3:40	4:05-5:05	5:25-6:25
STEAM					
AV. PRESSURE LB. G.	148	149.7	152.4	148.8	149.9
AV. TEMP. DEG. F	—	358.8	360.4	350.7	359
QUALITY		DRY AND SATURATED			
EXHAUST PRESSURE	0	0	0	0	0
AV. R.P.M.	208.4	206.9	205.4	203.3	202.3
LB. STEAM USED	229.95	321.2	433.6	562.95	729.65
AV. M.E.P. HEAD END	22.50	36.7	51.48	67.26	83.39
" " " CRANK "	18.35	28.77	41.48	54.54	69.05
I.H.P. HEAD END	52.20	83.00	117.25	151.64	187.07
" " CRANK "	40.90	63.63	91.09	118.55	149.35
" " TOTAL	93.10	146.62	208.34	270.19	336.42
LB. STEAM PER HR PER I.H.P.	24.70	21.91	20.81	20.84	21.69

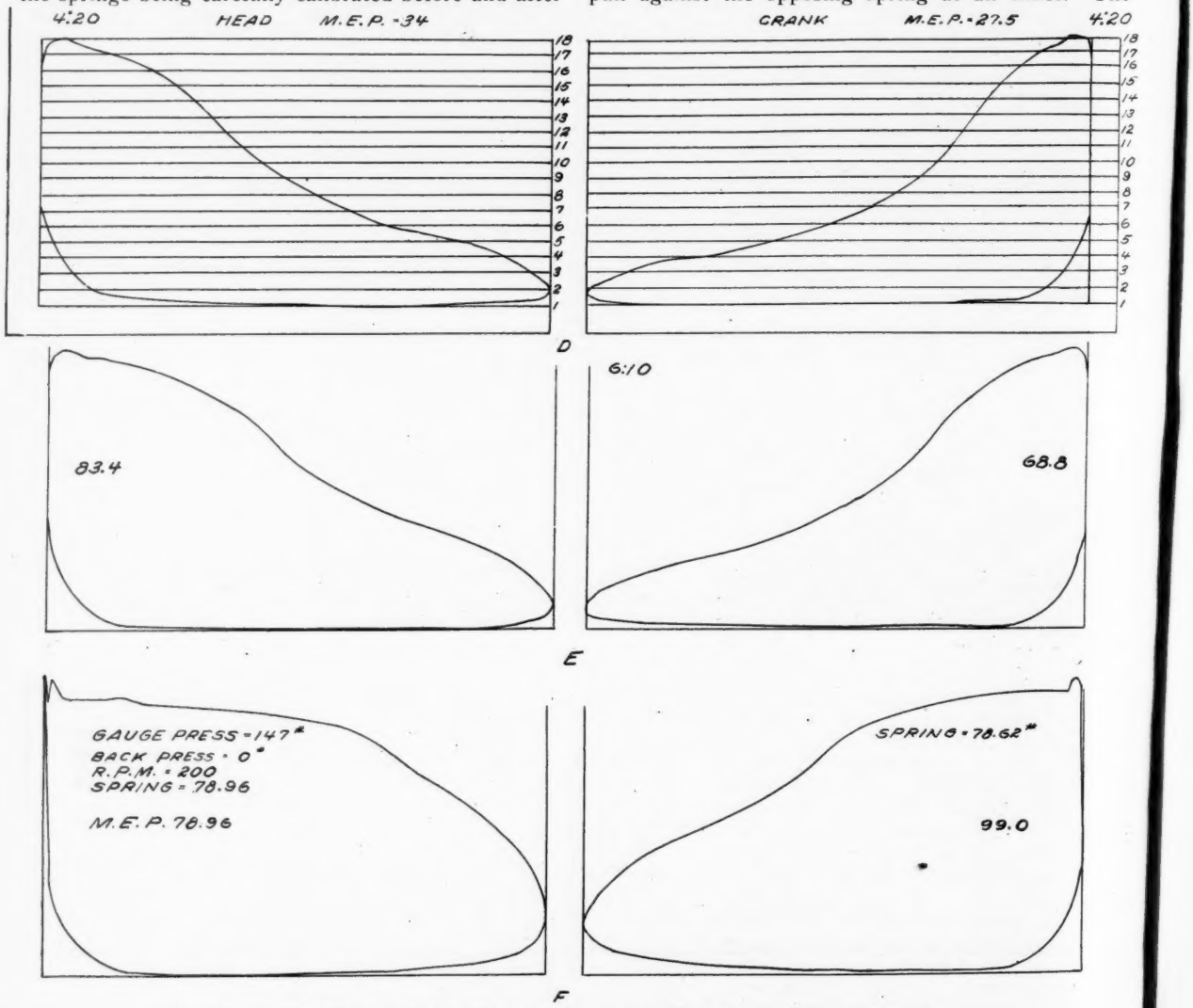


FIG. 9B. INDICATOR DIAGRAMS FROM TESTS AT 150 LB. STEAM CHEST PRESSURE

Dimensions of the engine tested were as follows: Diameter of the cylinder 16.046 in. Diameter of piston rod 2.855 in. Length of stroke 22 in. Scale of indicator spring for the head end indicator 78.96. For the crank end indicator 78.62. All readings were taken every 5 minutes and each test was continued for exactly 1 hour.

Tests at 125 lb. were run on March 26 by Frank Ide, the company's designing and testing engineer, and the tests at 150 lb. were run on May 7, in the presence of the writer. As the 2 curves practically agree, the tests of March 26 are accepted as correct.

For any who may care to work through and check the series of tests the following figures are given:

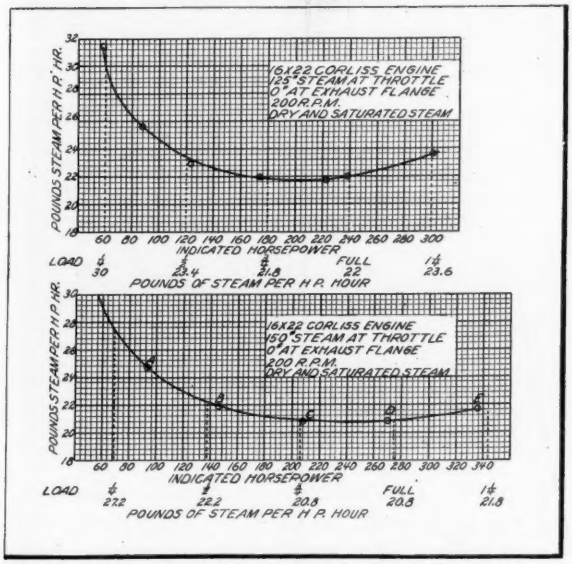


FIG. 11. CORVES OF STEAM CONSUMPTION OF 125 AND 150 LB. PRESSURE

Effective area of head end of cylinder 202.22 sq. in. Area of piston rod 6.40 sq. in. Effective area crank and cylinder head 195.82 sq. in. Length of stroke 1.833 ft. Horsepower constant for 1 lb. m.e.p. and 1 r.p.m.; head end, 0.01123445; crank end, 0.01087878. Tests are lettered A, B, C, D, E, and representative cards and the tabulation of results is given herewith. The steam consumption shows very satisfactory performance for the operating conditions under which the tests were run, and may well be carefully compared with other records.

After the economy tests were completed, the engine was loaded down by increasing the brakeload until considerable decrease in speed was shown, but it was noticeable that after a few revolutions the speed pulled back to 200 r.p.m., nearly that at which the heavy load test was run. The cards labeled F Fig. 9B were taken under these conditions and show a horsepower being developed at 465.2.

IN A PLANT using compressed air through 60 ft. of hose for riveting, trouble was experienced in holding the pressure during the time of cooling the rivet, the edge of the head becoming cold and not setting snug to the plate. A bigger cylinder on the riveter did no good, but a receiver close to the riveter and a big connection pipe to the riveter remedied the trouble, providing sufficient air to follow up the riveter piston with little drop in pressure.

STEAM CONSUMPTION DIAGRAM

Chart for Finding Theoretical Steam Used, Velocity After Expansion Between Any Pressures, Heat Available, and Duty per 100 lb. of Steam

BY means of this chart and the accompanying scales the steam consumption of a perfect engine or turbine can be determined immediately for any given steam conditions, and by comparing the steam consumption of the perfect heat motor with that of an actual heat motor, the efficiency ratio of the latter is found. As ordinarily done by reading off quantities on the chart and making calculations therefrom, considerable time is consumed and there are also many possibilities of error, but by the use of the De Laval Measuring Scale accompanying this chart, the heat energy available between any given limits, the velocity of the steam resulting when expanded in a perfect nozzle, the steam consumption of a perfect motor in pounds per horsepower hour, and the duty of a perfect engine in millions of foot-pounds per 1000 lb. of steam can be determined at once without computation.

If the actual steam consumption of the engine is known, the efficiency ratio is then found by simple division. The quality of the steam at the end of perfect expansion, and also at the end of an actual expansion, are read off immediately from the chart. Knowing this, the volume of the mixture at the end of the expansion may be determined by reference to any steam table.

Example

SUPPOSE the steam has a pressure of 150 lb. gage; that its temperature is 500 deg. F., corresponding to 134 deg. superheat and that it is to be expanded to a vacuum of 28 in.

The pressure lines run from the lower left hand corner to the upper right hand corner. The quality lines run from the upper left hand corner towards the lower right hand corner. The one lying between the 2 arrow heads represents saturation, corresponding to quality 1.00. The temperature lines are the curved lines lying nearly horizontal above the saturation line. Heat in B.t.u. is measure vertically and entropy is measured horizontally.

Find where the 150 lb. gage pressure line intersects the 500 deg. F. line. This is the starting point for measurement. Placing the scale vertically with the O at this point, it will be found that the 28 in. vacuum line intersects the scale at 345 B.t.u., which is the heat available to be turned into mechanical work in a perfect engine or turbine working between the given limits. Using the velocity scale instead of the B.t.u. scale it will be seen that the resulting velocity is 4160 ft. per second. Using the duty scale it will be seen that the duty of a perfect engine would be 267.5 million foot pounds per 1000 lb. of steam. Using the steam consumption per hp.-hour scale it will be seen that a perfect engine working between these limits would require 7.4 lb. of steam per hp.-hour.

Suppose that an equal engine working between these limits uses 11 lb. per hp.-hour. Its efficiency ratio is then $7.4 \div 11 = 67.3$ per cent.

The terminal point of expansion in the perfect engine lies, it will be noted, at quality 0.806. To find the quality for the actual engine using 11 lb. per hp.-hr., place the O point as before on intersection of the 500 deg. F. and the 150 lb. line, and note the position of the 11 lb. per hp.-hr. mark on the scale. From this point run horizontally until the 28 in. vacuum line is encountered. The point of intersection of the line that is run horizontally with the 28 in.

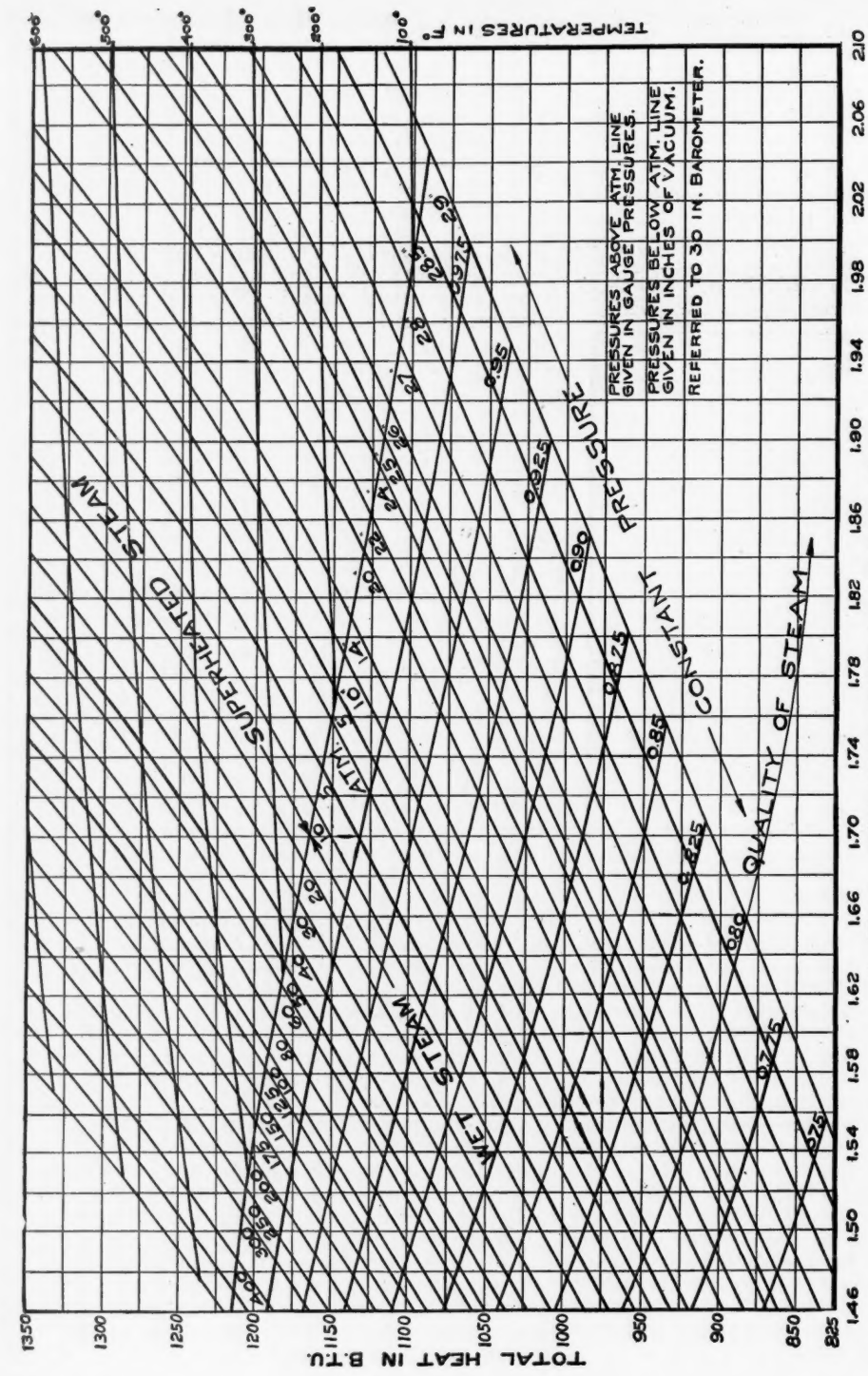


FIG. 2. VELOCITY AND HEAT AVAILABLE SCALE

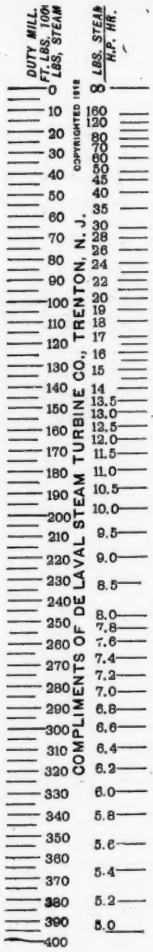


FIG. 3. SCALE FOR MEASURING DUTY AND STEAM USED

FIG. 1. STEAM CONSUMPTION AND VELOCITY CHART

vacuum line is found to be at about quality 0.932. Referring to a steam table it will be seen that a pound of saturated steam at 28 in. vacuum occupies 331.6 cu. ft., a pound of steam of quality 0.932 will therefore occupy $331.6 \times 0.932 = 309$ cu. ft.

To test these computations and to preserve a convenient tool for making computations, will do readers well to cut out chart and measuring scales and mount them on light cardboard, being careful not to distort chart or scales, during the mounting process. The chart, scales and description are placed before our readers by courtesy of the De Laval Steam Turbine Co.

EUROPEAN POWER PLANT PRACTICE

A New Water-Softening Process; Small and Simple Apparatus with Low Cost of Treatment

By Francis G. Wickware

REMOVAL OF SCALE-FORMING ingredients from boiler feed water is a problem for which a multitude of solutions are offered. Those salts which impart to water hardness of a "temporary" character, such as the bicarbonates of lime and magnesium, yield to the application of heat; they are precipitated as insoluble carbonates and may be removed by filtration. With the elements of "permanent" hardness, however, the case is different. These yield only to chemical treatment, and the diversity of the processes suggested for the purpose indicate that a method of softening of pre-eminent practical and commercial value is still to be discovered.

Difficulties of Purification

QUITE apart from their commercial economy, few of the processes offered for boiler-water purification effect the total removal of scale-forming ingredients. The reagents commonly employed are soluble lime or sodium compounds, less frequently soluble salts of iron or aluminum. The proportion in which they are added to the water is determined by the degree of hardness as disclosed by careful chemical analysis.

Only a very slight excess of reagent over the quantity theoretically required to precipitate the calcium and magnesium salts is permissible, since the admission to the boiler of water containing purifying agent in solution would have effects only less harmful than those of the untreated water. By the chemical law of "mass action," the speed of a reaction is determined by the degree of concentration of the reagents.

On account of the large volume of water and the relatively small amount of impurities to be removed, the concentration of the reacting salts in water softening processes is very low, hence the speed of reaction is extremely small. In ordinary practice at least 2 to 3 hr. are required to complete the reactions and precipitate all the calcium salts. Since the use of an excess of purifying reagent is prohibited, the only practicable method of hastening the reaction is to preheat the water.

The New Process

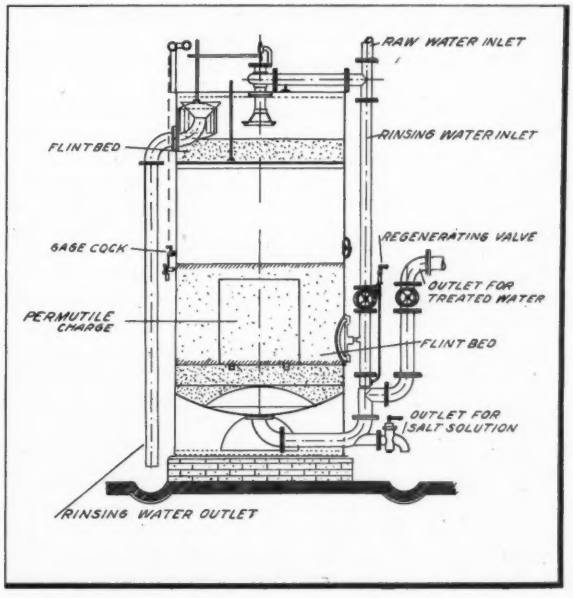
A NEW water-softening process recently introduced in Europe differs from those hitherto offered in that it employs a large excess of an insoluble reagent instead of a very slight excess of a soluble one. There occur in small quantities in nature a large class of minerals known as "zeolites," complex hydrated alumino-silicates associated with a number of other metallic bases. They differ from other silicates in the ease with which they exchange their associated bases with those of any surrounding medium, a property which has not been tilized industrially because of the difficulty of obtaining pure zeolites in commercial quantities. Their artificial preparation has been attempted, but only recently with success.

An artificial sodum zeolite,* containing silicon oxide, aluminum oxide, sodium oxide and water, is now made by fusing together feldspar, kaolin, clay and soda in certain proportions, and it is on this material that the new "permutite" process of water purification is based.

*Chemical formula, $2SiO_2$, Al_2O_3, Na_2O, $6H_2O$.

Chemical Reaction of Permutite

SODIUM permutite is a coarsely granular substance of a pearly lustre. In the dry state it can absorb 50 per cent of its own weight of water. Its action in removing calcium and magnesium salts from water results from the readiness with which the sodium in the permutite combination gives place to calcium or magnesium, forming soluble sodium bicarbonite or sulphate and insoluble calcium permutite.† The action in the case of magnesium salts is exactly similar.



SECTION OF APPARATUS FOR "PERMUTITE" PROCESS OF WATER SOFTENING

Ability to accelerate the softening process by the use of an excess of reagent is not the only advantage of the permutite system. Beyond the cost of the original charge of permutite, there is practically no expense for materials. Since the permutite is in itself insoluble and effects the softening of the water merely by exchange of metallic bases, its life is indefinite. When it has exchanged its sodium for calcium or magnesium to the economic limit, the permutite can be regenerated by treatment with a solution of common salt or sodium chloride, giving sodium permutite and calcium chloride.‡

The filtering apparatus shown in the accompany-

†This is illustrated by the following equations, the permutite being designated by P:

$$PNa_2 + CaH_2(CO_3)_2 = PCa + 2NaHCO_3.$$
$$PNa_2 + CaSO_4 = PCa + Na_2SO_4.$$

‡The reaction is as follows:

$$PCa + 2NaCl = PNa_2 + CaCl_2.$$

ing figure is of the open type, but a closed type for pressure working is employed in some cases. In either type, the charge of permutite rests on a bed of crushed flint and a similar bed of flint, carried on a perforated plate, is placed in the upper part of the filter to prevent the escape of permutite during the regenerative process. The depth of the permutite charge is determined by the hardness of the water and the speed of softening required.

Data of Operation

EVERY hard water may be perfectly softened by passing it through a layer of permutite 24 in. to 40 in. in depth at a rate of 10 to 16 ft. an hour, and the speed of filtration usually adopted lies between these limits. The permissible speed of filtration can be raised by increasing the depth of permutite charge, but it is limited by the fact that for efficient action the water must have time to penetrate the interior of the grains. The extreme limits of speed are: for water containing 0.01 per cent lime, approximately 27 ft.; 0.02 per cent, 16 ft.; and 0.03 per cent, 10 ft. an hour. The volume of water treated depends, of course, on the area of the charge.

Determination of the loss of permutite has been made in a Berlin boiler plant treating water containing 0.01 per cent of lime in an open filter without the upper protective layer of flint. The original charge was 1540 lb. of permutite containing about 29 per cent water; the loss in a year's working under unfavorable conditions was 77 lb. Nevertheless, the filter delivered the same quantity of water at the end of the year as at the beginning; its capacity after 8 regenerations was about 37,000 gal.

The regenerating solution generally used contains about 10 per cent of sodium chloride (common salt). This reaction also obeys the law of mass action and since the permutite has a greater affinity for calcium than for sodium, three to four times as much salt as is theoretically required is provided, and further to facilitate the action the solution is usually heated to 100 to 120 deg. F.

Admission of the solution to the filter is regulated automatically at a very slow rate to permit the solution thoroughly to penetrate the grains of permutite. Admission occupies 4 to 5 hr. and when the charge is completely impregnated the solution is left in the filter for about the same period. The charge is then drained and washed thoroughly to remove all traces of salt. Since the regenerative process is completed in about 8 hr., the installation of one filter will satisfy the demands of the ordinary small boiler plant, but where continuous service is required two filters will be necessary for alternate purification and regeneration.

A writer in a recent issue of "Gluckauf" states that at least 50 boiler plants are employing the permutite process. None of them has had any trouble with either corrosion or scale since the process was introduced. The sole precaution necessary is that the concentration of the soda salts in the boiler shall not exceed 2.5 to 3 per cent. The process is simple, requires a minimum of supervision and the apparatus occupies but small space. Coupled with these advantages, the low cost of treatment of about 3 cents per 1000 gal. will give the permutite process a prominent place among systems of industrial water purification.

SIMPLE MATHEMATICAL FORMULAS

What They Mean and How to Become Master of Them

By William Westerfield

MANY engineers will attempt the solution of a "Chinese puzzle" more hopefully than they will attempt the solution of the simplest mathematical problem in which letters or symbols are used. If we give a little attention to the method, we will find that the use of letters and symbols does not complicate a problem, but on the other hand, greatly simplifies the stating of it.

Let us take, for example, the problems of the lever, beginning with that of the lever of the first order as shown in Fig. 1. We have weight (W) multiplied by distance (b) from fulcrum to weight, and divided by distance (a) from fulcrum to power equals power (P).

The problem is stated as a formula thus:

$$\frac{W \times b}{a} = P.$$

Assuming that the value of W (weight) is known, also the distances a and b, we want to know what power will be required to balance the weight. Then let b equal 6 (in.), a equal 18 (in.) and weight (W) equal 60 (lb.). Then we have according to the formula $60 \times 6 = 360$, $360 \div 18 = 20$, that is the power equals 20 lb. This principle applies to all problems of this class. It should be easy to understand the application of this principle, for a little study will show that it is simplicity itself.

We know that the weight W is 60 lb., and that the weight is suspended from the lever at a point 6 in. from the fulcrum. The power P is applied to the other end of the lever at a point 18 in. from the fulcrum; therefore it is clear that the power being applied 3 times as far from the fulcrum as is the weight in such manner as to give the power 3 times the leverage of the weight, the power required to balance the weight will be only one third of the weight, or $60 \div 3 = 20$.

Again, if we know the value of the power P and assuming a and b to be the same as before, 18 and 6 in. respectively, we have the formula; P multiplied by a and divided by b equals W. Then we have the power P 20 (lb.) multiplied by 18 (in.), which equals 360 and this is to be divided by 6 (in.) and equals 60 (lb.) The formula is stated thus:

$$\frac{P \times a}{b} = W,$$

which is correct, as we have already seen.

It is a fundamental rule, that the distance a divided by the distance b must be equal to the weight W divided by the power P. Let us apply this rule to the problems we have considered. The distance a is 18 in., and the distance b is 6 in. Then 18 divided by 6 equals 3. Then proceeding with the weight W and the power P, we have 60 divided by 20 which also equals 3. This problem is thus stated:

$$\frac{a}{b} = \frac{W}{P}$$

That is, the distances a and b must be proportional to the power P, and the weight W. Just a little study of Fig. 1 will make this clear.

Applying this rule, let us assume that we know the values of the weight W, power P and distance a. We know that the distance b must be to distance a as power P is to weight W, or as 1 is to 3, therefore we have

$18 \div 3 = 6$ must be equal to the distance b as we have seen, because power P being ⅓ weight W, or weight W 3 times as great as power P, the distance b must necessarily be ⅓ the distance a.

Figure 2 shows the lever of the second order. It will be noticed that the fulcrum in this case is at one end of the lever, while the power is applied at the other, with the weight located at a point between. In this order the distance $b + a$ divided by b must equal the weight divided by P. Then, applying the rule, and assuming a and b to represent the same distances as in the foregoing calculations for the lever of the first order, we have a and b added equals 24, and this divided by b equals 4.

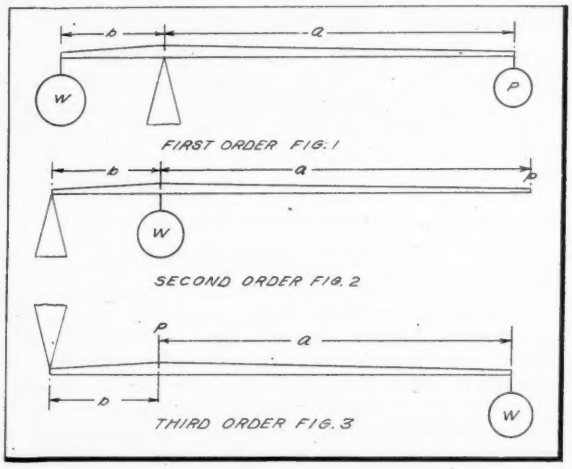


FIG. 1. LEVER OF THE FIRST ORDER FIG. 2. LEVER OF THE SECOND ORDER FIG. 3. LEVER OF THE THIRD ORDER

Therefore in this case if the power equals 20 lb, the weight must be $20 \times 4 = 80$ lb. The formula is thus stated:

$$\frac{b + a}{b} = \frac{W}{P}$$

Another formula applying to the lever of the same order is thus stated:

$$\frac{W \times b}{b + a} = P.$$

Then weight 80 lb. multiplied by (b) 6 equals 480, and b added to a equals 24. Hence we have $480 \div 24 = 20$, which is the required power P. Another formula is:

$$\frac{P \times (b + a)}{b} = W.$$

Then P equals 20, and b and a added together equals 24 and $20 \times 24 = 480$, which divided by 6 (b) equals 80,—the value of W.

In this last order of lever a greater weight is required to balance the power, notice also that the points of location of the fulcrum and the weight are changed. It will be seen in the first example that the power is applied at a point 18 in. from the fulcrum, while in the second example it is 24 in. from fulcrum. In the first case the weight has a leverage of 6 in. and the power has a leverage of 18 in. In the second case, the weight has the same leverage as before but the changed position of the fulcrum gives the power a leverage of 24 in., hence requiring a weight 33⅓ per cent greater than in the first example, because the leverage of the power is increased 33⅓ per cent. We have then $360 \times 0.33\frac{1}{3} = 120$ and $360 + 120 = 480$, which as we have seen is correct.

Figure 3 shows a lever of the third order. In this form b added to a and divided by b must equal P divided by W. Hence, taking the distances a and b, the same as before, we have 24, and dividing by b we have $24 \div 6 = 4$. Then if the value of P is 80, if we divide this sum by 4, we have 20 as a result, which is the value of W. Hence in this case the weight W must equal this value to balance P. In other words, W must be to P as b is to a plus b. This is the formula:

$$\frac{b}{b + a} = \frac{W.}{P}$$

Again, the power multiplied by b and divided by a added to b must equal the weight. We have therefore in this case $80 \times 6 = 480$, $6 + 18 = 24$, and $480 \div 24 = 20$ which is the value of W, which is again correct as we have seen in the previous examples. This is the formula:

$$\frac{P \times b}{a + b} = W.$$

Again we have the formula:

$$\frac{W \times (b + a)}{b} = P.$$

Therefore, we have seen that W equals 20, and b added to a equals 24, while b is equal to 6, the problem then is 20 (W) multiplied by 24 (a added to b) which equals 480, and this sum divided by 6 (b) equals 80, which is correct for the power P as we have seen.

It will be seen that by the use of these formulas, when we know the values of 2 of the quantities, we are able to determine the required values of the others.

A little observation of the form of the lever of the third order will show that it leads us up to a consideration of the old lever weighted safety valve.

THE "ORNERY" FLY

He is Dangerous as Well as Pestiferous and Should be Fought as Earnestly as Boiler Scale or Hot Bearings

THE Welfare Committee of the Iron and Steel Institute adds to the "Swat the Fly" campaign the following note of warning, which is worthy of careful attention and heed. The fly in the power plant is yet a fly and worthy of destruction.

Flies are a dangerous nuisance, they carry disease. People are just beginning to wake up to this fact. All flies are dangerous; house flies are especially so, because they are so numerous and because they come in contact with people and foods.

A single family fly lays an average of 120 eggs at a time. Four deposits of eggs may be made by one fly. Under favorable conditions the eggs become flies in about ten days. It takes about ten days more before these flies also lay eggs. It can be readily seen how fast flies will multiply if they are not destroyed.

They have no choice between the cleanest kitchen and unmentionable filth. Flies may infect foods with disease germs. They spread typhoid fever, as typhoid fever is a germ disease. Flies deposit typhoid germs in butter, milk and other foods—therefore, butter and milk should be kept covered and so should all other foods where possible. The germs deposited by flies are especially dangerous to infants and children. Flies like to feed around the eyes of sleeping children, and in so doing, may cause serious eye disease.

Flies must be kept from entering dwellings; all windows should be screened. Foods should be kept screened and tables should not be kept continuously set.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

SYNCHRONOUS MOTORS

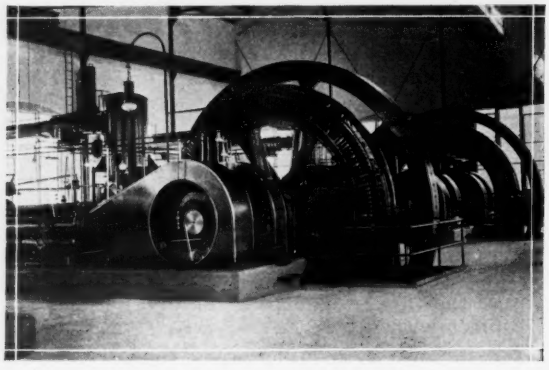
Suggestions for Their Installation, Operation and Maintenance

By Carl D. Knight

GENERALLY SPEAKING ANY alternating current generator will operate with more or less satisfaction as a synchronous motor, and unless there are some special operating features to be provided for, the 2 are often identical in construction.

There are 2 great advantages in the use of the synchronous motor, namely: it operates at a constant speed at all loads, provided the driving alternator runs at a constant speed, and its power factor is at all times under the control of the attendant.

This latter characteristic is often of considerable importance. It is a well known fact that the power factor of the induction motor even under full load conditions is seldom greater than 95 per cent, and often falls as low as 50 or 60 per cent at light load. The result is that an alternating current generator driving a considerable number of induction motors operates at a comparatively low power factor. If this alternator is loaded to its full kw. capacity at such a low power factor, overheating will



LARGE WESTINGHOUSE SYNCHRONOUS MOTORS DRIVING AIR COMPRESSORS

result. If the alternator is not loaded beyond its normal current capacity it operates at low load but with the same heating losses as at full load, on account of the reduced power factor. The advantage of the synchronous motor on such a system is, that by proper adjustment of its field current it may be made to draw from the line a current which is leading with respect to the voltage, and which will neutralize the lagging current taken by the induction motors. The resulting current in the alternating current generator can be brought into phase with the voltage and the generator will operate under its normal conditions. When used in this manner as a compensator for lagging current, the synchronous motor must be of larger size than required by its output, on account of the excess current which it draws from the line.

Disadvantages of Synchronous Motors

TO offset the advantages spoken of, the synchronous motor has disadvantages which limit its use to large sizes, and to places where it can be used as a compensator for lagging current. The chief disadvantage is that the motor has small starting torque even at full load current. The motor also requires a supply of direct current for its field excitation.

Starting Synchronous Motors

PRACTICALLY any polyphase synchronous motor may be started by applying full load voltage to the armature, leaving the field open until the motor has reached its normal speed. Such a procedure would require however, 2 or more times the full load current of the machine. Since the power taken by a synchronous motor starting in this manner is of very low power factor, the line disturbances might be considerable. Starting at full line voltage is also liable to induce in the field windings an excessively high voltage, often resulting in breaking down the insulation.

To limit the starting current to a reasonable value, auto starters or compensators are often used. These are similar and used in exactly the same manner as the starting compensators used with induction motors. When starting with a compensator the field winding is left open until the motor has attained its normal speed.

The arrangement just spoken of does not give any great amount of starting torque, and in most modern synchronous motors the revolving field of the motor is provided with a special auxiliary winding similar to the winding on the rotor of a squirrel cage induction motor. By the use of special alloys for this auxiliary winding it has been possible to construct motors having nearly 30 per cent of full-load torque at approximately 1½ times full load current. Besides improving the starting torque this squirrel cage winding also has a tendency to reduce the hunting or pumping effect which is often met with in the operation of synchronous motors.

In cases where the motor to be started is comparable with the size of the generator which drives it, it is often necessary to connect a small induction motor to the synchronous motor to bring it up to speed. When approximately normal speed has been reached the synchronous motor is thrown on the line as before, and the field closed immediately.

When a large starting torque is required, as for example, driving a considerable amount of shafting, it is often found impractical to start this load and the motor from rest together. In such instances it is customary to install a friction clutch or similar device between the motor and its load, so that the motor may attain its normal speed before any load is put upon it.

Occasional installations are met with where the motor is the only load on the driving generator. In such cases

it is possible to connect the synchronous motor to the line before starting the alternator. On starting the alternator the 2 will come up to speed together.

Cases have been known in which the motor was a small part of the load on the driving alternator, that is, the alternator was larger compared with the motor, when an auto starter was used to raise the voltage at start instead of to reduce it. This method gives a fairly good torque, but requires large current, and the operator must be sure that the motor windings will not be damaged before trying such a method.

In cases where it is desired to use an alternating current generator as a motor and no compensator is at hand, water rheostats can be used to good advantage, one being placed in series with each phase, and short circuited when the motor has attained its normal speed.

Since the synchronous motor itself is practically identical with the alternating current generator, the installation and operating hints given in the article entitled "Alternating Current Generators," in the May 1 issue of Practical Engineer, apply to the synchronous motor as well.

Synchronous Motor Troubles

FAILURE of a synchronous motor to start is often due to faulty connections in the auxiliary apparatus. This should be carefully inspected for open circuits or poor connections. An open circuit in one phase of the motor itself, or a short circuit will prevent the motor from starting. Most synchronous motors are provided with an ammeter in each phase, so that the last two causes can be determined from their indications; no current in one phase in case of an open circuit, and excessive current in case of a short circuit. Either condition will usually be accompanied by a decided buzzing noise, and in case of a short-circuited coil, it will often be quickly burned out. The effect of a short circuit is sometimes caused by 2 grounds on the machine.

Starting troubles should never be assumed until a trial has been made to start the motor light, that is, with no load except its own friction. It may be that the starting load is too great for the motor.

If the motor starts correctly but fails to develop sufficient torque to carry its load when the field circuit has been closed, the trouble will usually be found in the field circuit. First, determine whether or not the exciter is giving its normal voltage. Assuming this to be correct, the trouble will probably be found to be due to one of the following causes. Open circuit in the field winding or rheostat or short circuit or reversal of one or more of the field spools. Open circuit can often be located by inspection or by use of the magneto. Tests to locate short circuited or reversed field spools were outlined in the article on "Alternating Current Generators."

The majority of field troubles are caused by excessive induced voltage at start, or when the field circuit is broken. This excessive voltage may break down the insulation between field winding and frame or between turns on any one field spool, thus short circuiting one or more turns, or it may even burn the field conductor off, causing an open circuit.

Causes of overheating in alternating-current generators apply as well to synchronous motors. Probably the most common cause of overheating is excessive armature current coming from an attempt to make the motor carry its rated load, and at the same time compensate for a power factor lower than that for which it was designed.

If the motor is not compensating for low power factor, but doing mechanical work only, the field current should be adjusted so that the armature field is a minimum for the average load which the motor carries.

PULLING WIRE INTO CONDUIT

Practical Suggestions for the Manipulation of Various Conductors in a Conduit System

By Arthur O'Brien

WHEN drawing wire into conduit, it is a mistake to use so much force that the wire cannot be withdrawn. Conduits should be large enough so that excessive force is not necessary. Duplex No. 14 conductors can often be pushed through "easy" runs and small conductors Nos. 14 and 12 can be pulled in with the fish wire. Fig. 1 shows how they can be attached to the fish wire and Fig. 2 how the attachment should be served with tape to insure easy pulling. It spoils any fishing wire to draw in conductors that pull hard.

For conductors larger than Nos. 12 and 14, unless the "pulls" are easy, a pulling-in line which is drawn

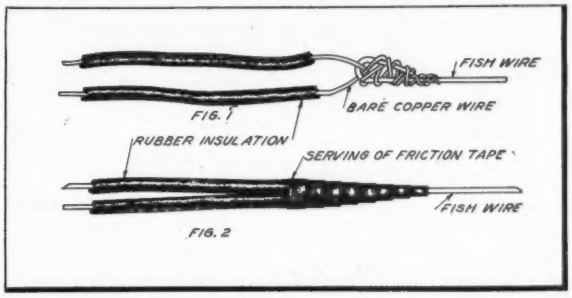


FIG. 1. ATTACHMENT OF CONDUCTORS TO FISHING LINE
FIG. 2. ATTACHMENT TAPED OVER

into the conduit with the fish wire should be used for drawing in the conductors. Nos. 10 or 12 B.W.G. galvanized steel wire, makes a good pulling-in line and is probably better for heavy work than rope. Two

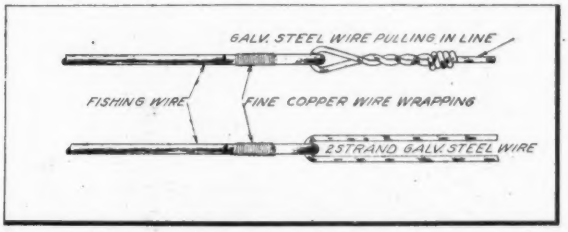


FIG. 3. ATTACHMENT OF PULLING-IN LINE TO FISHING WIRE

strands can be used if necessary. Braided cord is better than twisted rope because when tension is applied, the rope tends to untwist; sash cord is satisfactory for light work. Galvanized steel pulling-in wire can be attached to fish wire, as shown in Fig. 3.

Three or 4 links from a chain of no greater diameter than the line should be made up in the end of a rope or cord pulling-in line. Wires to be drawn in with a fish line can be attached to the links, as shown in Fig. 4, and one stranded conductor can be attached to a pulling-in line, as illustrated in Fig. 5. The attachment should be taped over to make it smooth. If 2 conductors are to be pulled in, one of them is "made up" into a loop in the end of the pulling-in line, and the insulation is trimmed from the conductor for 6 in. or more and the bared end of the other conductor is made up about the first one, forming a long tapering connection.

If a hard pull is expected, it is advisable to solder the connection which should be served with tape, Fig. 2. If 3 wires are to be drawn in instead of 2, the

attachment is the same with the addition that the bared end of the third conductor is made up around the other 2. The diameter at any section of the attachment must not exceed the over all diameter of the wires and the attachment should be in the form of a conical wedge. It is sometimes necessary to cut off, possibly, ½ of the strands of the bared ends and make up only the strands that remain, to insure that the attachment will be of sufficiently small diameter.

Force for pulling in conduit is, in the case of easy pulls, supplied by men; tackle blocks are permissible for heavy pulls. Cranes can often be used very effectively where they are available or snatch blocks can be used to guide the pulling-in line to some point

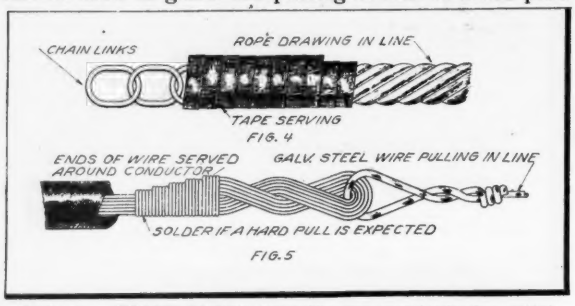


FIG. 4. CHAIN LINKS IN END OF PULLING-IN LINE
FIG. 5. ATTACHMENT OF STRANDED CONDUCTOR TO PULLING-IN LINE

where it can be either pulled with the crane hook or by the crane in traveling along its runway. A lever can be used for hard pulls by either repeatedly fastening the pulling-in line to the lever or by gripping it with a pair of pliers and then prying against the pliers with the lever. A short pull only is possible with each

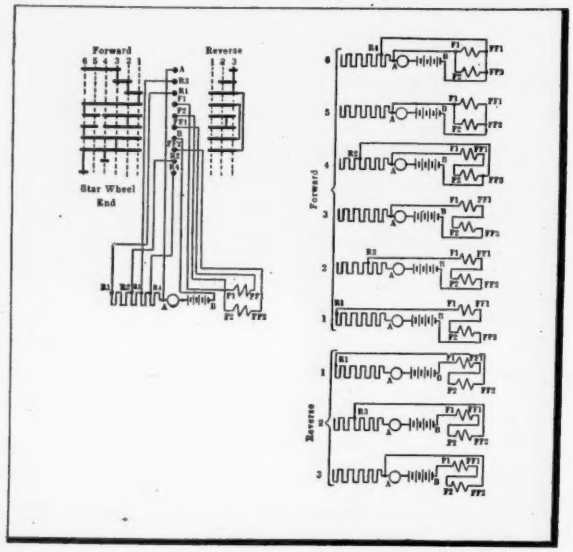


FIG. 1. DEVELOPMENT OF CONNECTIONS OF A CONTINUOUS TORQUE CONTROLLER WITH 6 SPEEDS FORWARD AND 3 REVERSE SPEEDS

setting and a succession of settings and prys is necessary to draw in the conductor.

In feeding conductors into conduit, care must be taken that they go in symmetrically and without lapping or twisting. If one conductor crosses another it may make a "hump" that will wedge in the conduit.

Soapstone blown into conduit renders pulling easier. One convenient way to get the powdered soapstone into the ducts, is to put it in an elbow then place the elbow at the end of the conduit and blow it in. Where the pulls are hard powdered soapstone should be rubbed on the conductors as they are drawn into conduits.

ELECTRIC VEHICLE CONNECTIONS

DESIGN of the controlling apparatus has been modified and the standard practice today is not to commutate the battery, but to combine the field windings of the motors with proper shunting and obtain a greater number of speeds at higher efficiency than was formerly possible.

Figures 1 and 2 show the connections of two late types of controllers. In Fig. 1 it will be seen that

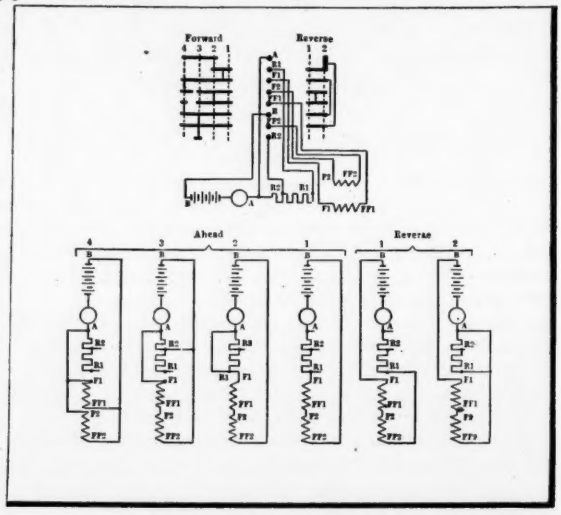


FIG. 2. DEVELOPMENT OF CONNECTIONS OF A CONTINUOUS TORQUE CONTROLLER WITH 4 SPEEDS FORWARD AND 2 REVERSE SPEEDS

on the first point the motor and batteries are in series with a resistance, the latter being cut partially out on the second point and wholly cut out on the third point. At the fourth point of the controller some resistance is shunted across the field windings; at the fifth point the field windings are connected in multiple and at the sixth point or highest speed the field windings are connected in multiple with a small resistance shunted across them. For the three reverse speeds resistance control is used.

In the type of connections shown in Fig. 2, the first and second points are connected to the rheostat with the field windings in series. The third point shunts some resistance across the fields which are still in series and on the fourth point the field windings are connected in multiple. The 2 reverse speeds are by resistance control.

FOR THE TRAVELER, or the man who directs travelers, the John Willy Hotel Directory will be found a great convenience. It is of a size to be conveniently carried in grip or pocket, lists some 15,000 hotels in the United States and Canada and gives their classification and in many cases, minimum and maximum rates. It covers practically all places of 1000 population and upward and gives the approximate population. Copies can be had of the publisher, John Willy, Chicago, Ill.

WALKER ELECTRIC VEHICLES

Balanced Drive Power Plant Enclosed in Hollow Rear Axle and Rear Wheels; Motor and Direct Connected Differenital Drive the Shafts, the Pinions of Which Drive the Wheels by Means of an Idler and Rim Gear.

BEGINNING with the single motor housed in the hollow rear axle, the power is transmitted through the direct connected differential and the 2-drive shafts extending from sockets in the differential into each rear wheel; the drive-shaft pinions transmit the power through the idler gears to the large rim gears fastened to the tire rims of the wheels.

In this way the power is transmitted in the most direct and efficient manner to the place where the power is used, that is, the tires of the wheels. The drive pinions and shafts have no bearing except the teeth of the idler gears, between which the pinions float in a balanced manner.

Details of Construction

MOTORS are designed to meet the most severe demands, and are of ample capacity to perform the work continuously with and the greatest efficiency. The hollow armature shaft runs in large imported Hess-Bright ball bearings.

Rear Wheels are of special design, of large diameter, and enclose the driving gear; the sides are formed by 2 pressed steel disks with radial corrugations in the form of spokes, which, in combination with the dished

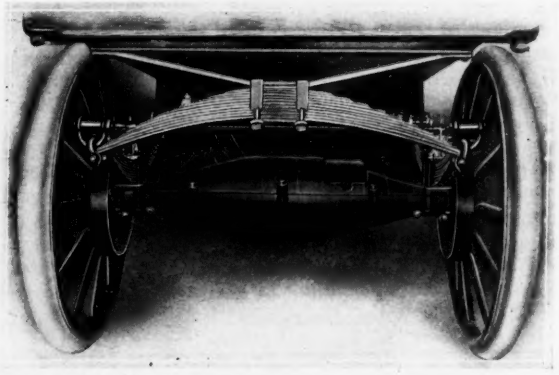


FIG. 1. POWER PLANT COMPLETE

form of the disks, give the wheels much greater strength and durability than is possible with wooden wheels. They are mounted on Hess-Bright ball bearings of large size.

Rear Wheels are partly filled with lubricant which is distributed over all working parts continuously when running, thereby insuring automatic lubrication and openings closed with screw plugs are provided in the disks to drain off the lubricant for occasional renewal.

Front Axle is a one-piece drop forging of special high-grade steel, I-beam section. Steering knuckles are provided with Timken roller bearings, top and bottom, which makes steering extremely easy, and reduces the wear and adjustment of these parts to a minimum. Steering knuckles and front wheel stub axles are integral drop forgings of nickel steel.

On Walker trucks of standard design a triangular reach of channel section steel extends from the extremities of the front axle to the chassis frame where the 2 arms unite in a ball joint. This gives the front axle an extra substantial bracing, which takes care of all jolts and bumps without twisting or bending strains to the axle, springs, chassis frame or body, as the ball joint permits the axle to assume any angle which the road surface necessitates. Springs are made of Vanadium spring steel.

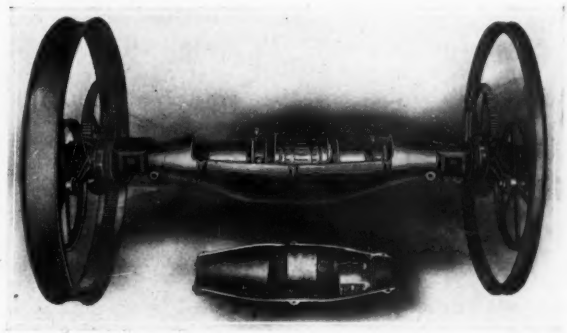


FIG. 2. DETAILS OF POWER PLANT WITH HALF OF MOTOR CASING REMOVED

Battery is usually housed in the battery box located between front and rear wheels underneath the main frame of the vehicle and supported by substantial steel cradles and is accessible through a trap door; also through side doors on each side of the battery box.

To keep the operator informed as to the condition of the batteries an ampere hour meter is furnished with vehicles and shows the driver at a glance how

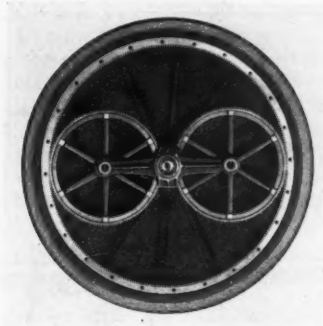


FIG. 3. CASING OF WHEEL REMOVED, SHOWING DRIVE SHAFT PINIONS, IDLER GEARS AND RIM GEAR

much current he has consumed and how much he has left. A little experience teaches the driver how to operate the vehicle in the most economical manner. The meter makes it easy to keep accurate records of current used per mile, trip, day, week, month or year, so that the owner knows the exact cost and can easily compare it with other vehicles.

There are 4 or more speeds forward and the same reverse, all controlled by the left hand. With right-hand steering, left hand on the controller lever, and right foot on the brake pedal, the driver has the vehicle under perfect control without shifting hands or feet. For the reverse, a pedal is pushed down and the controller operated as usual.

Walker Vehicle Co., Chicago, are the manufacturers.

ELECTRICAL CALCULATIONS

Application of Arithmetic and the Slide Rule in Calculating the Size of Conductors for Electric Light and Power Service

By Richard Howarth

IN practical electrical work the slide rule has many varied applications and as in other branches of engineering has proved to be of great value as a time and labor saver.

To illustrate the slide rule for this class of work a number of examples found in everyday practice are introduced, showing how they are solved both arithmetically and by means of the slide rule.

Finding the Area of a Conductor

ALL wiring formulas contain a constant which represents the resistance of a circular mil-ft. of commercial copper at a temperature of 75 deg. F., that is a wire one ft. long and having an area of one circular mil. This resistance is usually accepted as 10.8 ohms, but for all practical purposes 11 ohms is close enough. In interior wiring it is useless to exercise such refinement in the value of the resistance of a circular mil-ft. of copper, especially when the purity of the copper is unknown; when the difference between the successive available sizes of wire on the market is about 60 per cent.

What is the cross-sectional area in circular mils of a conductor 1000 ft. long and having a resistance of 0.652 ohms. Arithmetically this problem can be expressed in as follows:

A=L×C÷R; where A=area in circular mils, L=length of conductor, C=the constant and R=resistance. Substituting figures we have 1000×11÷0.652=16,871+c.m., which, by referring to a wire table will be found to correspond closely to a No. 8 B. & S. gage copper wire.

To calculate this on the slide rule perform the multiplication, 1000 times 11, mentally, the result is 11000, then over 11 on D place 652 on C and under the right hand index on C find 1687 on D. To find the decimal point by the method of approximate cancellation we see that 0.652 goes into 11 approximately 16⅔ times, multiplying by 1000 gives 16,667, therefore the answer is 16,870 c.m.

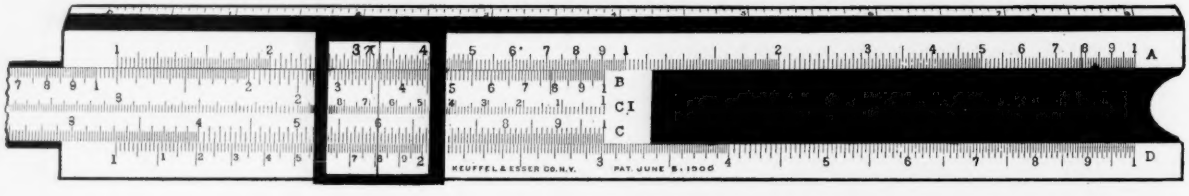


FIG. I. FIRST SETTING FOR FINDING SIZE OF WIRE CARRYING 450 AMP. 600 FT. WITH 6 PER CENT DROP

To find the size of wire for any current on a 2-wire direct current system:

$$A = \frac{11 \times 2L \times I}{E}$$

A=area in c.m., 11=constant, L=length of circuit one way, I=current in amperes and E=drop in voltage.

Example: What wire should be used to carry 450 amperes a distance of 600 ft., the allowable drop being 6 per cent and the e.m.f. at the end of the circuit 115 volts?

Volts at generator=115÷0.94=122.3.

Volts lost in line=7.3.

$$\text{Then } A = \frac{11 \times 2 \times 600 \times 450}{7.3} = 813{,}698+\text{c.m.}$$

To perform these operations on the slide rule proceed as follows: Multiplication of the first 2 factors in the dividend is so simple that the problem can be determined most rapidly, mentally, then place 73 on C over 22 on D and place runner over 6 on C. Bring left hand index 1 on C under runner and under 45

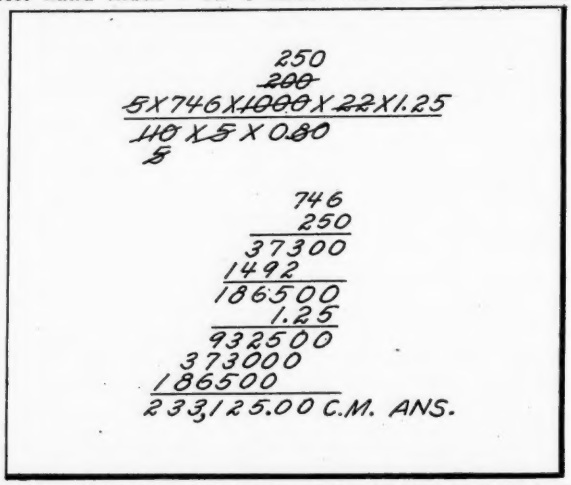


FIG. 2. ARITHMETICAL CALCULATION OF SIZE OF WIRE FOR MOTORS RATED IN HORSEPOWER

on C read 814 on D, the required size of the conductor in circular mils is now determined when the decimal point is located which we can do by approximate cancellation as follows: 7.3 goes into 450 approximately 60 times, 60×600=36,000; 36,000×22 is 792,000; therefore the final result has 6 figures to the left of the decimal or the answer, as calculated by the slide rule, is 814,000 circular mils.

To determine the size of wire necessary for direct-current motors rated in horsepower, the following formula will be found useful:

$$A = \frac{P \times 746 \times L \times 22 \times 1.25}{E \times C \times \text{efficiency}}$$

The 25 per cent excess current required by the Underwriters is taken into consideration. In the formula, A=areas of wire in circular mils; P=rating in hp. of the motor; L=the distance in feet to the motor; E=the impressed e.m.f. and C the drop in the line.

Example: What will be the required size of wire for a 5-hp. 110-volt motor with an efficiency of 80 per cent, 1000 ft. from the main feeders, the allowable drop to be 5 volts. Figure 2 shows the method of arithmetical operation.

It is evident that cancellation is the simplest operation to eliminate several of the factors. To com-

plete the problem with the slide rule place right hand index 1 on C over 746 on D. Locate runner over 250 on C and bring index 1 on left-hand C under the hair line and under 125 on C find 233 on D, the required size of the conductor in circular mils is now determined when the decimal point is located which we may do mentally as follows: For 746 substitute an even value, say 800, then 800 times 250 is plainly 200,000; this multiplied by 1.25 is 250,000. We know, therefore, that our answer has 6 figures to the left of the decimal point and is, according to the slide rule calculation, 233,000 c.m.

EXPERIENCE ON THE ROAD

A Phantom Load

By Leonard Work

CIRCULATING current between alternators in parellel may result from a variety of causes, chief among which is a tendency toward unequal generator speed, the latter resulting from slippage or bad joints in belts, difference in pulley diameters, angular variation in prime movers and supersensitive or faulty engine governors. There are other less frequent causes which are sometimes difficult to discover. Quite recently there happened a case of this latter kind which is of particular interest, not only because of the unusual and perplexing cause of the trouble, but because of the liability of its happening wherever similar conditions prevail.

Two 150 kw. 2-phase alternators of the revolving armature type were reported as indicating on their ammeters a quiet, steady current of about half load on each machine when run in parallel without any load connected to the bus-bars, but when either machine alone was run in parallel with an incoming power line, which came in through transformers, no such effect could be seen.

Trouble was said to date back but a short period to when one of the generators had a number of armature coils replaced. Subsequent to these repairs an increase in station load required the operation of both generators. The evidence of unbalanced circulating currents seemed to be very strong and convincing, and, therefore, an examination of the offending machine was immediately begun. The armature winding was of the closed-coil type with taps brought out mechanically and electrically at points 90 degrees apart. The windings and connections were traced out and checked several times and proved to be absolutely correct and precisely like those of the other generator, so it was obvious that, whatever was causing the trouble, the repaired armature coils were surely not responsible, and therefore this clue, which at first was so promising, had to be abandoned. Tests were then made to eliminate all the usual causes of circulating current, such as slipping of belts and friction clutches, etc., but in these respects everything was found normal and in good condition. Voltages on the phases of both machines registered alike.

Circulating current or a phantom load, such as was observed in this plant, can be produced with two alternators in parallel when the field of one unit is under or over-excited, the proper adjustment being reached when, upon manipulating the field rheostats without altering the bus-bars voltage, the total generator amperes are at a minimum; but here no field adjustment could be found which would reduce the apparent load. Both of the generators were of the compensator type, in which an induced current proportional to that in the main leads is rectified by a commutator and circulated around the fields, the effect being similar to that of the compound winding of a direct-current machine. It was believed that there was a possible chance for trouble here, although it did not seem likely, especially at no-load. However, a test was made with all the compensator circuits on both machines cut out, but this had not the slightest effect on the trouble.

The steadiness of the phantom load was such as to excite suspicion that some kind of apparatus might be connected to the generators or bus-bars unbeknown to the attachees of the plant, and although repeated tracing out of leads and switchboard wiring revealed no such connections, in order to make double sure, the lines of the switchboard were disconnected and the machines paralleled through temporary wires straight from one unit to the other. After this was done an ammeter inserted in the circuit shrowed that the exasperating circulating current was still present. Every attempt on the part of the investigating engineer to discover a solitary symptom of disorder had gone down in defeat, and as apparently all other possible tests had been made, saturation curves were taken, but these threw new light on the question.

The capacity of the plant was so materially reduced by the circulating current that the engineer was urged to try again to locate the source of the trouble, but it was only after considerable persuasion that he was induced to make another trip to the distant city to investigate anew. Again taking up the thread of investigation, and reflecting that an exchange current between machines could be caused only by super-imposing or combining two voltage waves of unequal value, it was evident that this was what was taking place here, but from some cause as yet obscure. Means for measuring or comparing the waves of the machines were lacking; however, in the absence of an oscillograph, it was finally decided to investigate in a somewhat crude manner the main and side circuits of each alternator separately by means of an incandescent lamp, which, when connected while the machine was run slowly, would keep pace with the alternations in brightening and darkening with each wave of voltage. The alternations of the machines were readily followed and in each case the pulsations on both phases were found to be normal. However, upon connecting to a side circuit of one of the machines, that is, to one lead from each phase, a peculiar effect was noticed. Coincident with each revolution of the armature the waves could be seen to attain a maximum and minimum; the intensity of the flashes ascending and descending with each revolution. This indicated almost as clearly as an oscillograph could have done that the e.m.f. in this section of the winding rose and fell at one particular place instead of being constant as in the other machines. The reason for this irregularity could only be due to lack of uniformity in the strength of the magnetic flux around the armature.

Investigation as to the cause of the difference in field strength developed the fact that the air-gap at the upper portion of the field was almost twice as great as at the lower part, and this was the cause of the rise and fall of potential in the side circuits previously mentioned. This effect, because of its being super-imposed with the voltage of the side currents of the other machine whose potential did not vary, caused at every revolution a surging back and forth of current in the lines paralleling the machines, which, however, at full speed registered on the ammeter as a steady current.—The Electric Journal.

WEBSTER SYSTEMS OF STEAM HEATING

THE 2 systems of heating which are most commonly installed by Warren Webster & Co., are the Webster Vacuum system and the Webster Modulation system. The vacuum system is adapted for heating large buildings, while for the smaller and medium size building the modulation system is recommended.

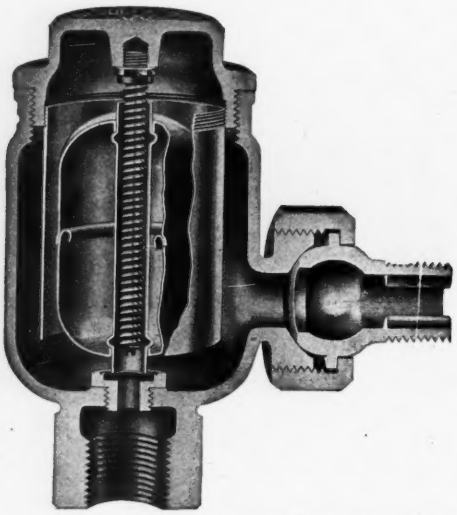


FIG. 1. CROSS SECTION OF WATER SEAL MOTOR

The Webster Vacuum system is used principally in connection with exhaust steam plants, although it is used on live steam installations as well. With this system there is little or no back pressure on engines,

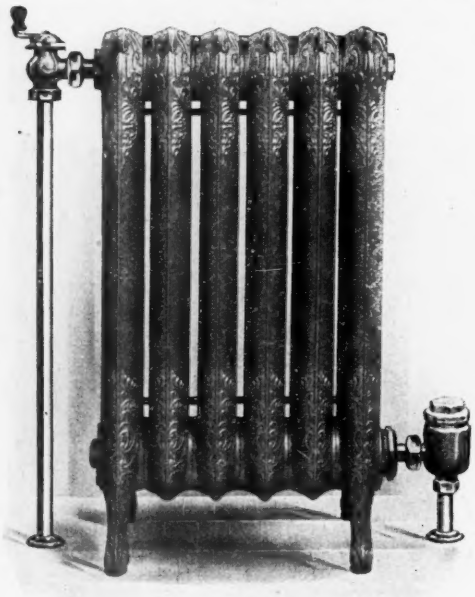


FIG. 2. RADIATOR EQUIPPED WITH WATER SEAL MOTOR AT RETURN END AND MODULATION VALVE AT SUPPLY END

and no air valves are required. The condensation may be saved, purified, and used for boiler feeding.

The various resistances causing back pressure are estirely overcome by connecting a vacuum pump to the return line which exhausts the air and water of condensation therefrom until a sufficient degree of vacuum has been created in the entire return-system to secure a flow from the drip points and radiation regardless of the pressure in the supply line and radiators. It is thus possible to circulate steam throughout the entire system at a minimum pressure.

If no other device than the vacuum pump alone were used, the steam would still "short circuit" through the return connections of the nearer radiators; thus increasing the return pressure, or in other words, destroying the vacuum. This most important function of maintaining the vacuum and preventing loss of waste of steam is performed by the Webster water seal motor shown in Fig. 1. One of these motors is placed on the return connection at each drainage point in the

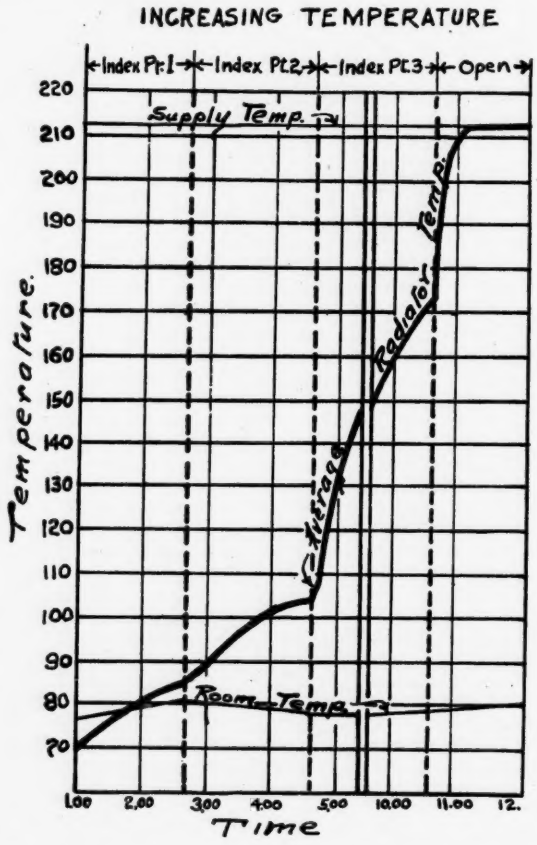


FIG. 3. CURVE SHOWING INCREASE OF TEMPERATURE AS MODULATION VALVE IS OPENED

mains, radiators and coils throughout the system and connected to the return line. The motor requires no adjustment, and automatically ejects water and air from the radiator without permitting the escape of steam. In this way, all air valves are eliminated.

With the Webster Modulation system of steam heating, positive circulation and complete condensation of low-pressure steam is secured in a noiseless 2-pipe system. Flexible control and close regulation of temperature are possible, and the automatic ejection of water and air secured. Just the amount of heat de-

sired for a comfortable room temperature may be secured by adjusting the modulation valve which is placed at the supply end of each radiator.

By this valve, located within easy reach of the top of the radiator, the effective area of heating surface can be quickly changed. The steam, from a pressure of a few ounces to 1½ or 2 lb., is admitted to each radiator, the amount being controlled by the modulation valve having a figured dial. The instant steam is admitted to a radiator, the air is forced to the bottom and is driven into the return main through the water seal motor. The air is finally discharged into the atmosphere through a vent valve, while the water of condensation is returned to the boiler. A damper regulator, specially designed for this service, closely regulates the boiler draft according to the amount of steam required.

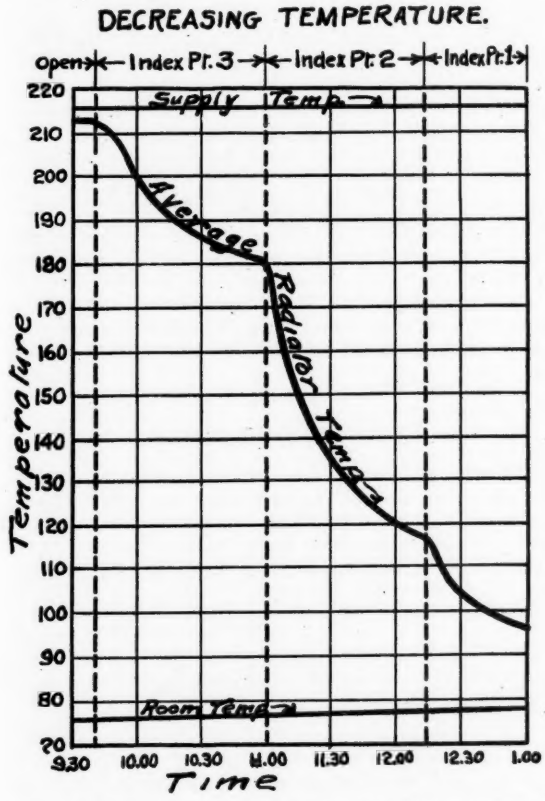


FIG. 4. CURVE SHOWING DECREASE OF TEMPERATURE AS MODULATION VALVE IS CLOSED

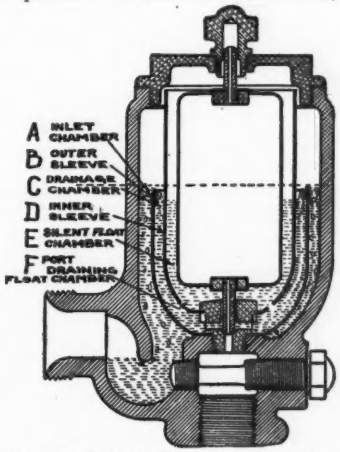
The efficiency of this modulation system makes possible the use of smaller piping than in ordinary hot water or steam systems, and less radiation may be used than with hot water heating. In Fig. 2 will be noted the arrangement of the modulation valve at the supply end of the radiator with the water seal motor at the return end.

Some interesting tests were recently made by the manufacturer to determine the exact extent to which the modulation valve in conjunction with the water seal motor actually controlled the radiator temperature. Two runs were made and the results are shown in the accompanying charts. In the first, the modulation valve was entirely closed at the start, being opened step by step to the wide open position. In the second run this operation was reversed, starting from the a full head of steam on the radiator and with the modulation valve wide open, and going through the graduations in the reverse direction to index point 1. A glance at the 2 curves reproduced shows at once the decided effect upon the average temperature of the radiator caused by these changes in valve opening.

MONASH NOISELESS RADIFIER VALVE

WATER of condensation entering the inlet chamber A over the outer sleeve B into the drainage chamber C and through the ports F in the bottom of the inner sleeve D enters the silent float chamber E. Through the center of the float is a separate passage for the free and constant escape of air into the return.

When the water in the silent float chamber E is at the line of flotation the float rises and the valve opens, emptying the drainage chamber C. With the outrush of water from the drainage chamber C the level of the water in the silent float chamber E is gradually lowered by the escape of a little water through the ports F when the float sinks, closing the valve.



SECTION OF MONASH NOISELESS RADIFIER

In the Monash Radifier the float and drainage chamber are separate, each to perform its individual function. In the drainage chamber C drainage into the return is direct, rapid and absolute. In the silent float chamber E the body of water is always still, with a slight and gradual lowering of the line of flotation—thereby insuring silence in action of the motor float. The separate drainage chamber C insures direct discharge of oil, grease, core-sand and dirt into the return pipe, not permitting them to enter the silent float chamber E.

NEW YORK CHAPTER of the American Society of Heating and Ventilating Engineers held its first annual dinner at Keen's Chop House. Before introducing the speaker of the evening, Mr. Mackay asked the members to sing a song written especially for the occasion with special reference to the New York Chapter. He then introduced Wm. J. Baldwin, dean of the heating profession, who spoke at some length on Steam Fitting and Ventilation Forty Years Ago. President Mackay then introduced in order, D. D. Kimball, who spoke on Ventilation with Especial Reference to the Architect; H. J. Barron who spoke on As I See Things Today. J. A. Donnelly who spoke on The Needs of the New York Chapter; and Frank K. Chew spoke on Conservation of Energy and Concentration.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

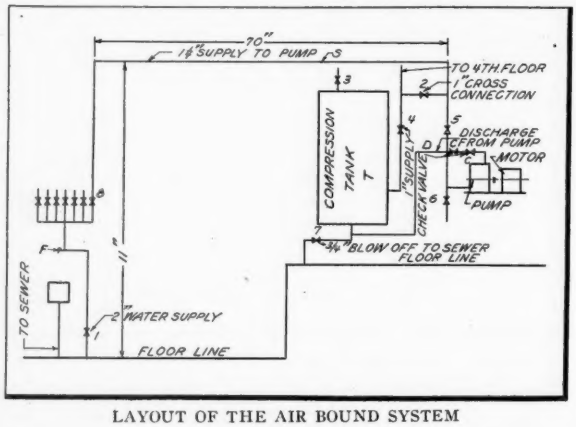
AIR BINDING THE PUMP

THE pump and tank outlined in the diagram were installed during the summer of 1910 and used to supply water to the fourth floor, as the city pressure at times is inadequate.

Valve 1 is the main shut off for the water supply to building. Valves to different lines are indicated by symbol. Water is supplied to pump through valve 8 and pipe S passing through valve 5 into pump, thence discharging through check valves C C and pipe D to tank T through valve 4 to fourth floor.

Valve 2 is in a cross connection and is used, in case pump is out of service or city pressure is high enough, by closing valves 4 and 5, and opening valve 2. Water then goes direct to fourth floor. Valve 7 is used as a blowoff for empting tank T and is connected to sewer. Valve 6 is for the purpose of draining out the pipe below the level of cross connection. As it was not expected to be used much it discharges into the room. A pail is used to catch the contents.

The pump is of the centrifugal type, built by the



LAYOUT OF THE AIR BOUND SYSTEM

Chicago Pump Co., under automatic control and is direct connected to a single-phase, 220-volt Century motor. This outfit worked quite satisfactorily after its installation.

On Friday nights tank T is emptied after closing water supply valve 1 by opening blowoff valve 7. When the tank is releaved of pressure air valve 3 is opened. Monday mornings air valve 3 is first closed, and then blowoff valve 7. In this manner a good air cushion is obtained which will last through the week or longer.

When cold weather arrived in accordance with my usual custom, water pipes were drained every night. As there was no danger of freezing water in the compression tank T, this was not drained except at the end of the week as described above.

The manner of draining these pipes was as follows. Water supply valve 1 was closed as well as valves 4 and 5. The cross connection valve 2 and the ¾-in. cock F were opened. This drained off all water in pipes above the basement.

The first morning after thus emptying water pipes water supply valve 1 was opened, as were valves 4 and 5. Valve 2 was closed. On starting up the pump it was found impossible to get enough pressure to carry water to the fourth floor. Upon investigation the trouble was found to be due to the fact that when valves 4 and 5 were closed and valve 2 opened for the purpose of draining, the water was drained from pipes above the basement, but below the level of pipe S the water was trapped in vertical pipe 5.

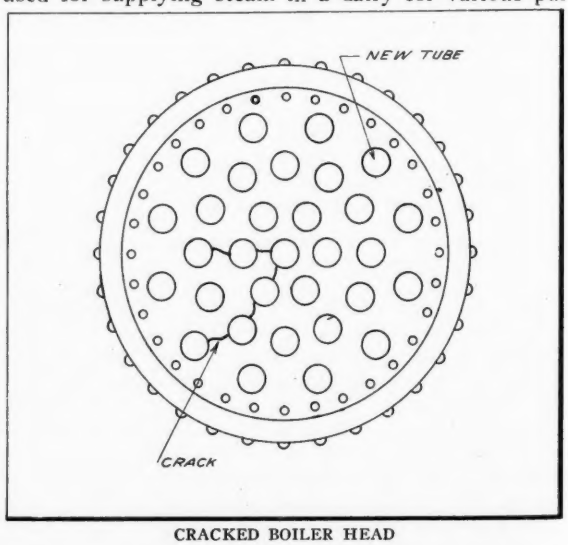
On opening water supply valve 1 as well as valves 4 and 5 and closing valve 2 the air between valve 8 and valve 2 was trapped in pipe S. The water in vertical pipe 5 was forced into tank T, but when the trapped air in pipe S reached the pump there was no further movement of water, as the air was merely churned.

By opening valve 6 the air was forced out. Valve 6 was then closed, water was admitted to pump and there was then no difficulty in getting sufficient pressure.

J. P. F.

A DANGEROUS BOILER

RECENTLY I was asked to send a man over to a small plant to put a new tube in a boiler which was 7 ft. by 3 ft. 6 in., with 30, 2-in. tubes, and was fitted with a safety valve set to blow at 20 lb. It was used for supplying steam in a dairy for various purposes and the man returned to the shop and asked me to go over and see the boiler before he put in the tube. I went to see it and found that it had a crack which continued through 6 tube holes as shown in sketch and all 6 tubes were loose. I informed the owner of



CRACKED BOILER HEAD

the dangerous condition of the boiler. "That's alright," he said, "she has been like that for over a year and I only carry 15 lb. on her and it only gets up to 20 lb. and blows off about once or twice a day, so there is no danger at all." He laughed at me for being too particular and said that he only had the boiler in to cover the law, as it requires that all apparatus in a dairy be steamed before using. I think that the inspectors who have to look after these dairies should understand a little about boilers. This one is still working.

Richard Howarth.

FORCE TENDING TO BURST BOILER

IN the April 15th issue C. E. Aldrich comments upon answer given by the writer in the February 15th issue. The question reads: "What pressure in pounds tends to render asunder from 'end to end,'" etc., which means to pull it in two along a longitudinal plane. My answer was $d \times l \times p$ equals total pressure tending to render asunder.

Where d equals diameter in inches equals 72.
l equals length of boiler in inches equals 216.
p equals pressure per square inch in pounds 100.

Total pressure equals 1,555,200 lb.

Mr. Aldrich says pressure tending to render asunder equals $p \times a$.

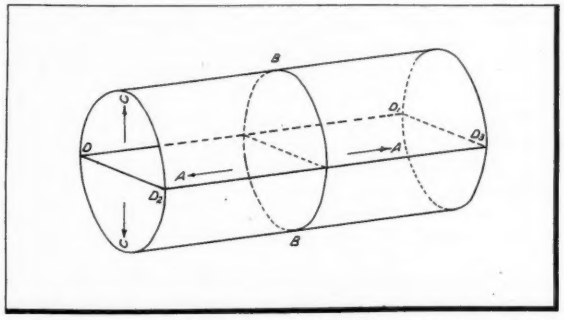


DIAGRAM OF BOILER SHOWING DIRECTION OF FORCES TENDING TO BURST IT

Where a equals area in square inches of end of boiler.
p equals pressure in boiler or 100 lb.

Then $72 \times 72 \times 0.7854 = 4071.5$ sq. in. and $4071.5 \times 100 = 407{,}150$ lb. total pressure and that it would be the same if the boiler was one inch or 100 ft. in length.

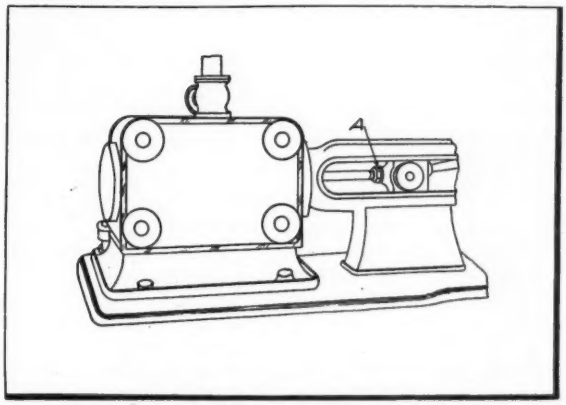
If the cylindrical shell shown in the illustration is subjected to an internal steam pressure the forces tending to rupture it will resolve themselves into 2 forces, one force indicated by the arrows AA acting in the direction of the length, tends to tear the shell in a traverse plane as BB. The other force, indicated by the arrows CC, acting perpendicular to the axis, tends to rupture the boiler in a longitudinal plane as through D D_1 D_2 D_3. These 2 forces are opposed by the tenacity of the material of which the shell is composed.

It is easy to see that the magnitude of the force tending to rupture the shell in a transverse plane is equal to the area of the head in square inches times the steam pressure per square inch, as stated by Mr. Aldrich. But the magnitude of the force tending to rupture the shell in a longitudinal plane, that required in the problem, is equal to the internal diameter, multiplied by the length, both in inches, multiplied by the pressure per square inch, just as stated in my answer. From the above it will be plain that my answer was correct for the problem as stated.

John Mitchell.

AN EMERGENCY

I AM much interested in the articles which appear in Practical Engineer on "What to do in Emergencies." Here is one from my experience. We had a 26 by 48 in. Harris Corliss engine running 80 r.p.m.. One morning when the writer was just coming in there started up a severe pounding, all on the head end, no noise whatever on the crank end. The engine was fitted up with a screwed crosshead



CYLINDER WHICH POUNDED ON HEAD END

and the rod was held from turning out by a check nut at A. From my experience with the engine I was sure what the trouble was; taking time to look at the crosshead to see if it was all right, I discovered or thought I did, what the trouble was. Now something must be done. Every time it turned over it shook the whole building. The lock nut had slacked and the rod had backed out until the clearance had all been taken out and the piston was striking the head.

Now some one tell us what I ought to have done.

Student.

EMERGENCY PUMP REPAIR

SOME 3 yr. ago the writer was appointed master mechanic of a newly opened coal and iron mine in the mountains of British Columbia. Arriving at the mining camp I soon found that my job was no sinecure for the machinery was in a deplorable condition and rapidly qualifying for the junk pile; in the boiler room which was equipped with 2 300-hp. Babcock & Wilcox boilers, one could not hear oneself speak, on account of the hiss and screech of escaping steam from leaky steam pipe joints, valve stem glands, etc., and in the adjoining engineroom, conditions were no better, owing to the heavy pounding of the air compressors, the fan engines, were knocking at every revolution, and the brushes and commutators of the electric generators were sending off a shower of sparks.

The engine room floor was flooded with water from the various leaking glands of the circulating and boiler feed pumps, which were also sadly in need of overhaul, repair and adjustment.

The day following my arrival at the mine, while the manager and myself were discussing the possibility of shutting down from Friday night to the next Tuesday morning to effect some necessary and urgent

repairs in the boiler and engine rooms, the underground foreman hurried up to where we were standing and reported the pump at the bottom of the shaft had again broken down and the workings were being rapidly flooded.

On questioning the foreman it appeared that this pump which was a vertical sinking pump of the bucket and plunger type, 18 by 14½ by 10 in. by 24-in. stroke, and was slung in the shaft bottom drawing water from a sump 10 ft. deep, had twice before broken down through the steam piston becoming loose on the rod owing to the stripping of the threads on both rod and in the nut. They had attempted to repair it the first time by burring up the threads and riveting the end of the rod over a champher on the top of the piston rod nut, but this did not hold and the second attempt was made only a couple of days previous by reducing the thickness of the nut and again riveting the end of rod over it and then boring a hole through both rod and nut and inserting a steel taper pin. Yet the pin had sheared and the rivetting again drawn and the steam piston was again loose and the pump consequently useless.

To understand properly the gravity of the situation it is necessary to state that the shaft was sunk only about 40 yards away from the bank of a swift flowing river, the water from which percolated through the surface and subsoil to such a degree that the vertical pump had to be kept running to its full capacity to keep the water down in the sump. The shaft was 110 ft. deep, where the coal vein was struck and from this point the vein took a dip at an angle of some 35 deg. and had been followed for a distance of about 150 yards; from this main roadway headings had been driven off on both sides to win the coal, the last heading being at the bottom of the dip, or incline.

At the top end, or where the dip commenced, the sump was sunk 10 ft. and all the water coming down the shaft and drainage from the dip (the latter being pumped from the bottom by a duplex pump to the sump), was collected here and discharged to the surface and back to the river by the vertical sinking pump. As there was no standby, or spare pump, available, nor yet any spare or duplicate parts for the sinker, the gravity of the emergency will be apparent, as the sump was already full and overflowing down the dip and flooding out the lower workings.

No time was to be lost, so I set 2 engineers to work to draw the pump and piston rods and bring it together with the piston to the surface and in the meantime I had a look around for what facilities I might be able to find for the repair I had in view; these were few enough in all conscience, but I finally unearthed a set of ⅞-in. taps (the largest we had) and ⅞-in. stocks and dies. In the smith's shop there was a small vertical hand drill press and by the time I had a ⅞-in. tapping drill made and collected the necessary tools, etc., the men had the piston and rod on the surface and brought to the smith's shop.

A short examination of the rod showed that nothing could be done with it in the way of turning it down and putting on a new thread and nut (even if we had had a lathe which we had not), so placing the piston on the taper I marked the rod flush with the top side of the piston and then proceeded to cut the end off rod with a hack saw 1/16 in. below the scribed mark. I fancy, by the looks I caught sight of on the face of the manager and some of the men present, that they thought I was crazy, but no remarks were made. When the end of the rod had been sawed off a ⅞-in tapping hole was centered and scribed, the rod being then placed under the drill press, a hole having to be cut in the floor to let the rod be vertical, owing to its length while being drilled. A hole about 2¼-in. deep was drilled and then tapped well down to the bottom and while this was being done as no rod steel was to be found in the store with which to make a suitable stud a piece had to be cut off the round end of a steel crowbar of the diameter required; a good full thread was then put on this piece of steel and by the time the hole was tapped the stud was ready.

A couple of narrow air channels were cut longitudinally along the end of the stud entering the rod and the stud was then screwed well home and bottomed with thick red lead paint. Meanwhile I had the smith make a steel washer ¼-in. thick and 2½ in. in diameter with ⅞-in. hole in the center. The piston was then placed on the rod, well up against the shoulder at the large end of taper and showed it had a bare 1/16 in. draw on the stud. The washer was put on and screwed hard down with a new nut, which was further locked with a thin locknut back of which a ⅛-in. steel split pin was fitted up close.

The job was now complete and looked all right so I got the men to take off the piston again, send it and the rod down the shaft when we soon had rod replaced, the piston put on and screwed hard down, the joint on the cylinder cover made, the glands repacked and the pump restarted.

I must admit I was somewhat anxious at first as to whether the stud would stand the heavy intermittent shocks and strains to which it was subjected, but it stood the test although I thought it rather light for the work, yet it was the largest that could be put in, as the taps, stocks and dies at our disposal precluded our putting in a larger stud. The manger was good enough shortly after when all the water was out of the mine and the pump working satisfactorily to compliment me on the repair, but added with a twinkle in his eye, "I wondered what you were up to when I saw you cutting the end of the rod."

The diameter of the rod was about 1 11/16 in. at the small end of the taper.

A new pump and piston rod, with piston and other spare parts, were immediately ordered, but were not found necessary to be used during the period I remained at the mine. The old repair holding good. The whole job from the time the pump stopped till it was running again did not exceed 3½ hr., which I think is not a bad record considering the facilities at our disposal and that when stripping the pump and replacing the parts we had to work suspended in the shaft under a perfect deluge of water.

John Creen.

REMEDY FOR BURSTING STUFFING BOX

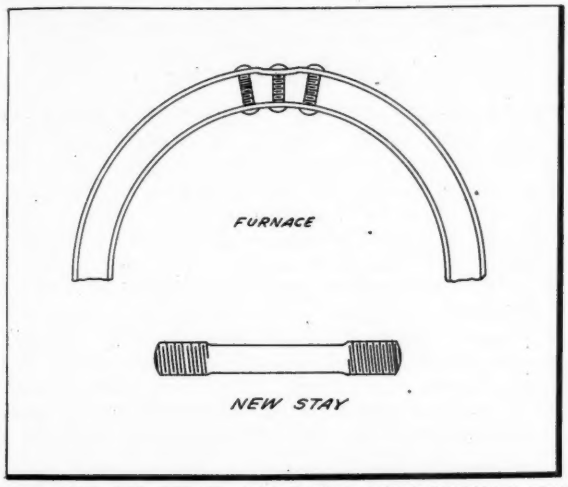
IN regard to the ammonia compressor stuffing box bursting every time it was shut down, I believe the best remedy is to tighten up the nuts on the stuffing box just enough to keep from smelling the ammonia odor and then take a split set collar with 2 set screws in it and jam it up against the stuffing box gland.

Every time they start the compressor to running, they should loosen the set collar and slip it back out of the way and loosen nuts and then it is ready for operation. This collar should be made with slots in it in order to slip over nuts and studs on the gland.

J. R. Ginn.

RENEWING STAYS IN BOILERS

WHEN boiler stays are corroded or leaking they are taken out and renewed. In renewing them it is customary to tap the hole in the plates large enough to give a full thread for a larger stay. I do not think this a good practice as it is bad for the plates, making them too rigid at that spot, which causes them to buckle.



STAY BOLT FOR REPAIR AND FAULT WITH COMMON BOLT

After the holes are tapped out in the plates and the stay fitted, it should be taken out and put in a lathe and have the part between the plates reduced down to the size of the original stay. By doing this the plates will retain their original curve. Accompanying is a sketch of what I think the new stays should be like, and also a sketch of the defect likely to be caused by using larger stays. James A. Campbell.

EMERGENCY DASHPOT ROD

IN the March 1 number Martin McGerry describes a kink by means of which he kept his Corliss engine running until a new dashpot rod arrived. If a 3/16-in. wire will serve for a dashpot rod for a week, why not for a year? And if a 3/16-in. wire will do the work why should a heavy rod be used? If the office of the dashpot rod were merely to pull the valve closed, then a 3/16-in. wire might answer; but this is only one-half of the story. The other half is not perhaps so obvious but just as essential.

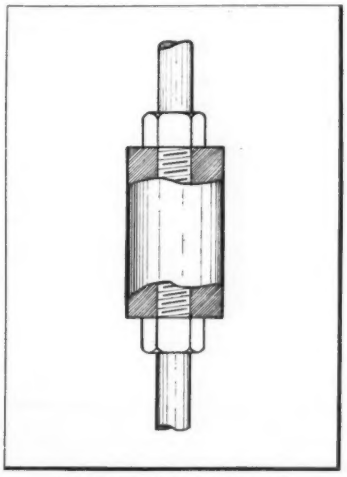
Suppose your Corliss is running along smoothly and you pick up a wrench and lossen the lock-nuts on the dashpot rod and turn the rod so as to shorten it, giving it a full turn, what happens? The engine begins to limp, now, taking steam only on other end. The block is down so low that the latch can't get hold of it. So the valve will not work until something is done to raise the block within reach of the latch. This is the other half of the story. The dashpot rod must not merely close the valve but it must move to a certain definite point, in order that the block may be engaged by the latch. If the valve shuts a bit too far, the engine becomes single acting and remains so until the trouble is remedied. To perform this office the dashpot rod requires a stiffness not possessed by a 3/16-in. wire.

It is true, that for a certain load, a certain pressure and a certain degree of lubrication, the device of wire and spring might be adjusted so that it would pull the valve nearly closed and the shoulder on the latch would push it the rest of the way. But let the load increase, or pressure drop, or the valve get a little more oil and down comes the block too far. For this reason the device won't work in the engine room, no matter how nice it looks on paper.

It is an easy matter and one requiring few tools to drill and tap out a piece of rod and thread the dashpot rod and join it as indicated in the figure. I have indicated locknuts to prevent backing out, but pins would do as well; and if there are locknuts at both ends of the rod and both threads in the joint right hand, it would be safe to omit the locking feature entirely.

If taps and dies are not at hand, the hole could be drilled full size and the broken ends of the rod inserted and pinned, though this would not be nearly so good a job as the other. If, as is more likely, the break is under the locknut at the end of the rod, merely run the thread upon that end, saw the rod in two, and join as above, being careful to preserve original length of rod.

And in the meantime, while this repair is being made, the engine may be run without a dashpot rod. It may seem inconsistent to claim that the wire and spring device will not work and then say the engine can be run with nothing in the place of the broken rod, but it isn't inconsistent at all. In fact both dashpot rods may be taken off and the engine kept in operation. Just put in the pin, run off the governor belt and put a 2-armed, level headed governor at the throttle. William E. Dixon.



REPAIR OF DASHPOT ROD

SETTING SLIPPED ECCENTRIC

I NOTICED an inquiry by G. A. W. on page 433 of the April 15th issue of Practical Engineer in regard to setting an eccentric that had slipped. My method is, for a D valve with direct rocker arm, to place the engine on dead center, then place the eccentric 90 deg. ahead of the crank, then open the throttle a little, turn the eccentric in the direction the engine is to run until steam comes out of the drain cock or indicator tap, which has been left open.

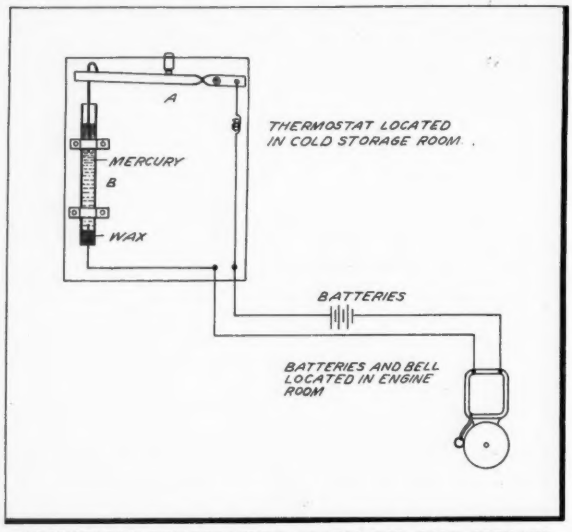
If the engine has an indirect rocker arm the process will be the same except the eccentric will be set 90 deg. behind the crank, then turn in the opposite direction from the way the engine runs until steam issues from the drain. Wm. Carpenter.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Temperature Alarm for Cold Storage

I HEREWITH enclose a sketch showing a temperature alarm which I have made and which works very satisfactorily. I have 2 of them installed in the cold storage rooms of the Holley Cold Storage Co. plant where I have charge. The falling temperature of a cold storage room when the engineer is busy might result in a bad loss to the company and freeze apples, peaches or whatever is in storage, hence this



ADJUSTABLE TEMPERATURE ALARM FOR COLD STORAGE ROOMS

device to warn me when the rooms are cold enough.

This alarm can be made as follows: Take a glass tube about 8 or 10 in. long and ⅜ in. diameter and close one end used for the bottom with sealing wax in which the bare end of a No. 18 gage magnet wire is inserted. The tube is filled about ¾ full of mercury and a float of wax is placed on top of the mercury in which a bare piece of the same magnet wire is inserted and bent as shown in the sketch. This tube of mercury is made secure by fastening it to a base with 2 clips.

At the upper end of this base, the adjustable lever A is attached and electric connections made as shown. If the temperature should fall during the day or night, the mercury will contract, the float descend and the circuit close so that the bell will ring. Adjustment of the lever allows setting the alarm for different temperatures.

Martin McGerry.

Lead Pipe For Calking

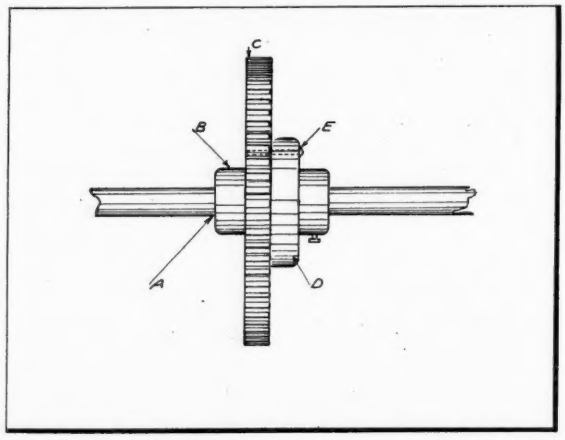
FOR calking pipe joints, I have had good results by using a piece of lead pipe about 6 in. long which was cut lengthwise, flattened out and cut into strips ¼ in. wide. A calking tool is used in doing the work.

G. M. Brooks.

A Breaking Coupling

THE boiler plant of one of the largest paper and pulp mills in the country is equipped with the Taylor Underfeed Stokers. As engineers who are familiar with this stoker know the coal is forced on to a stationary grate by means of plungers, each plunger taking 15 lb. coal at a stroke. The number of plunger strokes is recorded automatically by a meter so that this affords an excellent method of finding the amount of coal used.

Power is supplied to the stokers by means of chain drives from a main shaft, which extends the entire length of the boiler room. Formerly when a chain would catch, a plunger jam, or something of similar nature happen, it would mean a broken chain or a



COUPLING WHICH GIVES WAY UNDER EXCESSIVE STRAIN

sprung length of shafting. In order to avoid the more serious breaks it was thought that if one part of the drive could be made weaker than any other part this weak part would be the first to break if something went wrong. With this in view the "breaking coupling" was devised.

By looking at the accompanying sketch it will be seen that this consists of a gear, loose on the shaft and half of a flange coupling faced up against it. Through the gear and coupling a hole has been bored and a pin is inserted in this hole, i. e., passing through both gear and coupling. The hole may be drilled about ½-in. and bushed down to any desired size; in this case the pin ocnsisted of a 20 penny nail. The size of the pin, of course, is governed by the power to be transmitted and can best be determined by experiment.

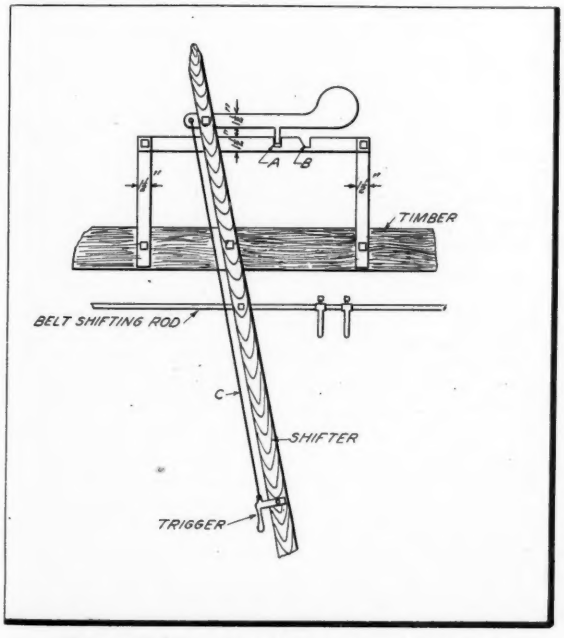
Referring to the sketch again, A is the main drive shaft; B a collar holding the gear C in place; D, half of a flange coupling; and E a pin fitting snugly in the hole which has been drilled through C and D. The gear C is loose on the shaft and were it not for the

fact that it is connected to D by means of a pin, no power could be transmitted to the shaft.

Now suppose a chain catches or a plunger jams, thus putting undue strain on the shaft, through the shaft this excess strain is transmitted to the breaking coupling and the pin E shears off. The thing to do now, of course, is to find the cause of the trouble, remove it, replace the pin in the breaking coupling, and start up again. If it had not been for this ingenuous device instead of a pin to replace we would in all probability, have had a broken chain or coupling. The use of the "breaking coupling" is not limited to the boiler room alone as it may be used wherever power is transmitted by means of shafting. H. H. Latimer.

Safety Belt Shifter

SAFETY devices have saved the hands and fingers of many men and here is one that has been put to practical use and found highly satisfactory. It must of course, be arranged for each case, in some places we put the safety weight below the shifter rod but the idea can be made to work with any style of belt shifter. Above the timber to which the shifter lever is attached a frame work is built as shown. The lever is extended to carry a sort of dog which has a weight at the outer end. This dog falls in slot A when the machine is not running and to shift the belt to the running position the dog must be raised by means of the handle on the



BELT SHIFTER THAT LOCKS IN OFF POSITION

shifter lever and the rod C. Slot A has parallel sides which prevent the lever from shifting in either direction until the dog is raised. When the dog drops into slot B the belt is in running position. One side of this slot is cut at an angle so that the belt may be shifted in case of accident to the off position without the necessity of raising the dog.

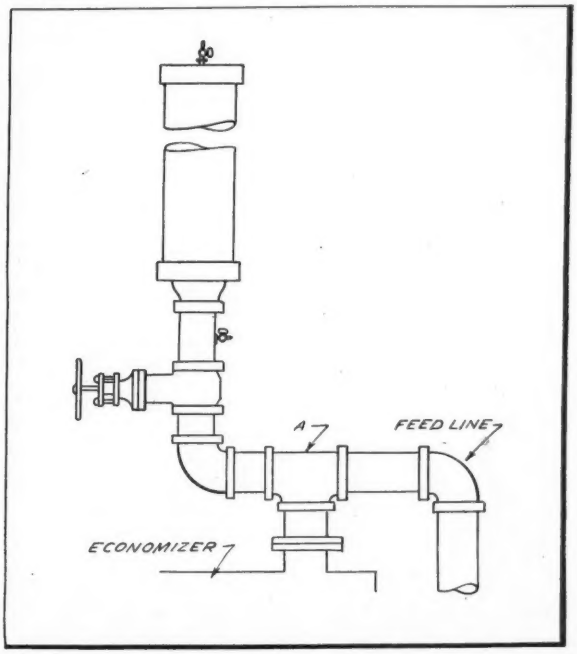
The shifter should be so hung that the lever is in a vertical position when the machine is running so the weight will not move to the off position due to jar of working machinery. F. E. Wilkinson.

Economizer Troubles

NO doubt some of the readers of Practical Engineer have had experience with economizer troubles, and a suggestion in that line may be of help to some co-worker.

The trouble in question was with an economizer located on top of a battery of 7 boilers, with a total rating of 2200 hp. The feed water temperature in the heater was maintained around the 200 deg. mark, and left the economizer at 300 deg.

Violent hammering in the feed line occurred at irregular periods, with such force that it was impossible to keep gaskets in for any length of time, so an air chamber of 8-in. wrought iron pipe 8 ft. long, as shown in the sketch, was connected to the tee at A, which replaced an ell.



LOCATION OF AIR CHAMBER ON ECONOMIZER SUPPLY LINE

The chamber was provided with a shutoff valve and necessary drain in case the chamber should fill with water.

Some of the readers may say that uneven feeding, such as at noon, would cause this action, but such was not the case. The hammering appeared and disappeared without regard to time or conditions. Gases were entering on an average temperature of 520 deg. and leaving at 400 deg.

Since applying the air chamber there has been no sound whatever in the feed line, and our gasket supply has been greatly reduced. Frank W. Ballinger.

RULES FOR FIRST aid in case of an electric shock are being studied by a Commission on Resuscitation from Electric Shock. The commission was organized on the initiative of the National Electric Light Association, and is composed of members of the American Medical Association, the National Electric Light Association and the American Institute of Electrical Engineers. The commission recommends the prone method as the best in the hands of laymen for maintaining respiration, and a chart, to be issued under the auspices of the National Electric Light Association, is being prepared giving the details.—The Iron Age.

FROM THE FIREMAN SON TO HIS ENGINEER FATHER

Donald Substitutes for His Fireman and Causes Comment From His Superiors by Reduced Coal Consumption and Absence of Smoke

MY DEAR FATHER:—

I had begun to think that you were never going to answer my last letter, for you know when a fellow is a long way from home that "every day is a week," as far as time is concerned. About 2 days after I write to you, it seems that I can not get back to the boarding house fast enough to read the letter from you which I know should be there, and when I find none, my disappointment is deep.

Well, whatever the cause, I was exceptionally glad to hear from you again, especially at this time, for since I wrote you last, I have "had my chance," as they say, and I flatter myself that I have made good.

About 3 weeks ago, I was putting in some new grate bars in one of the fireboxes to replace some that had outlived their usefulness, and as I was inside, I asked the fireman, Fred, to pass me the new bars. Even in your day, grate bars were not light, and they have not become any lighter with the lapse of time. Fred never learned this till that day.

He picked up a double bar to hand me but it did not "come with him," as fast as he thought it ought, and his hand slipped off of it. Evidently Fred thought it was padded with cotton, or perhaps that this was the pattern. At any rate he was not spry enought in getting his No. 14's out of the way, and the bar stamped the pattern letter across his toes.

Well the surgeon found that there was no damage beyond a severe bruise, but Fred had to stay at home for a week or so, while yours truly kept one side hot and the other wet. Since the Chief showed me how to fire properly several weeks ago, I tried the trick frequently, and Fred was not adverse to giving me the opportunity whenever I felt so inclined. Usually he handed over the scoop with some cutting remark such as, "you'll never make er fireman ef you live t' be 's old 's ol' man M'thuselay," and took a long smoke while I was trying my luck at firing.

So when the Chief asked me if I thought that I could get away with it, I told him that I thought that I could, and he sent me a man from the yard gang to take my place wheeling in coal. Of course, you know it is comparatively easy to do anything as an experiment when you have some one there to step in if things go wrong, but although I felt that I could do it all right, yet when it came to a showdown, I will admit that I was a little shaky in the knees when Fred limped to the hack that had been summoned for the occasion, and left me there with the direct descendant of Julius Ceasar to help me keep things hot.

Well," 'tis better to face a danger than live ever in fear," so I went to it determined to carry 110 lb. of steam if there was any virtue in coal and a No. 5. scoop.

Well, I didn't do so bad for an amateur, for I was determined that I would not let her "die" on me if I could help it. Then I made the mistake that I suppose nearly every new man makes the first time he finds himself in the same situation; I thought that to keep it from going back on me, I would see that it did not lack for coal, and just there is where I missed it.

Soon the steam began to drop a pound at a time and I put in coal and it seemed that the more I put in, the more it seemed to drop till it got down to 95 lb. and then it was a hard pull. I puzzled my brains trying to think what the old professor told us to do in a case like this, when we were at "Tech.," but for the life of me I could not think what it was till it was all over and then I remembered that he didn't tell us anything, for the reason that he never fired a boiler except with a leadpencil and a slide rule.

I found out right then, that firing a boiler is one of the things that you cannot learn out of a book. You can read all the boiler tests that have been run since Watt began firing but none of them say a word as to HOW to fire.

Of course I will admit that I was a little bit confused at the time, I am man enough to admit that right off the bat. I think that the Chief realized something of the kind was going to happen, for about the time I was ready to drop, he came in and asked what was the matter and I told him that I "could't hold it."

He came over and looked into the ashpit and then into the fire, and then instructed me to get the hose. I wondered what he was going to do but some found out when he turned water into the pit. Then he took the slash bar and ran it in under the fire all over but was careful not to disturb the fire much.

Then he slowed down the pump as, in my excitement, I had not given the water end of the plant much attention, till I found that I had a good 3 gages. With the pump running slow, he took the shovel away from me and hung it up on the wall and told me to sit down, which I did, wondering what he was driving at.

Soon the gage stopped losing,—and slowly commensed to gain, a pound at a time, from 85 up to 100. Then he opened the fire doors and showed me that there was still a big fire. Taking the poker he pulled out a number of clinkers with the hook, one side at a time and put in a few scoops immediately afterwards.

And do you know, father, almost before I knew it, there was a good 110 lb. of steam and the safety valves sizzling, and still a good gage of water in sight. And the chief was not sweating a drop, while I was about all in. When satisfied that everything was all right again he looked over at me and inquired with a kindly face. "What's the matter Mack, did you loose your head?" and I had to admit that I did. Then he explained all about firing and gave me a lot of sage advice that I absorbed like a sponge does water, the sum and substance of which was to "not overdo a good thing." If I had seen this motto blazened forth on a billboard, it would not have appealed to me but coming as it did on top of my interesting experience, I saw that while coal is necessary to raise steam in some places, there is such a thing as getting too much of it.

That experience furnished me food for thought for some time and when I sat down that evening at the boarding house, I thought over it a great deal. Now back at the Bergville Technical Institute, we learned (or were supposed to learn,) all about power plant practice in theory and the professor led us to believe almost that there wasn't anything to firing a boiler.

He made us copy lists of all the different coals from Rhode Island lignite to the best Welsh coal dripping with oil, and gave us the amount of air it required to burn them properly and the B.t.u. in a pound of it and the percentage of ash, and in fact everything that he could think of, but he didn't know how to tell us HOW to

fire it under a boiler so that the steam wouldn't go down. That is one of the things that I found must be learned on the job.
under a boiler so that the steam wouldn't go down. That is one of the things that I found must be learned on the job.

Well I hardly slept that night for turning a lot of those problems over in my mind and it wasn't till I heard the "Pacific Mail" go through with a roar at 1:26 a. m., that I finally went to sleep, and after I did get to sleep, I dreamed it all over again only a great deal worse.

Next day, however, I determined not to make that mistake again and I kept the hand glued to 110 as if it grew there. The chief came in several times and each visit was a little briefer than the preceding one till the last time he just walked through and smiled.

But I caught him several times out in the yard, looking at the top of the smokestack as if he expected to discover another comet. The last 2 times, he had the superintendent with him and I could see the chief talking to him earnestly, and laying down the law like some politician running for Congress.

Then they walked through the boiler room and never noticed me any more than if I had not been there. As they passed the boilers, the Chief opened the doors of 2 of them and was explaining something to the "old man" as if the fate of the entire works depended on it. I did not hear what they said and did not want to, so I went over to the pump and squirted a little oil on the rods to take up my attention.

Well, I got along all right after the first day when I fell down and after that it was easier. But the strange part of it is that I do not seem to use so much coal by from 1000 to 1500 lb. a day, so I asked the Chief one day whether the load was falling off any of late and he assured me that it was not falling off and, furthermore it was a little heavier if anything.

Still, I could not understand it at all, so I asked the Chief for an explanation, which he gave after thinking over the matter a long while, for he seems to be very slow on the talk.

"MacDougal," said he, "there are several things that go to make a good fireman and a good fireman is as hard to find as a good preacher. There are lots of preachers that can talk on religion and really believe what they say, but there are mighty few that can talk it, live it and do it so that everybody that they come in contact with will be made the better for it.

"It is just so with firing. There are lots of men who can unload coal from a gondola, or out of a coal car, or who can shovel from a pile into a wagon; but there are mighty few men who can stand in front of a boiler and put the coal on the fire when it is wanted, and where it is wanted. A man that can do that Mack, is a fireman, and if he can't do it, then he is a necessary nuisance.

"There are several things that go to make a successful fireman, and as I have lived in this town all my life, I know personally every man that calls himself a 'fireman'. I can say without fear of contradiction that in all this town of 40,000 people with a reputation as a manufacturing center that extends all over the civilized world, I can say that the real firemen who know their business and can handle the job so as to get all out of the coal that can be done under the circumstances, can be counted on the fingers of one hand.

"This may seem to be a broad statement Mack, but it is so nevertheless, and as you get older, you will remember what I have just said. It is a very easy matter to get the coal inside the firebox; but it is an entirely different matter to get it in RIGHT."

Just at this point it was necessary to fire up again, so I fired as near to the way that the Chief told me as I know how, one side at a time, and in couple of minutes, went over the other side, putting on a little at a time and not covering the fire excessively in any one place. This done, the Chief asked me to come outside where we could see the result.

"Mack," said he, as we gained a point of vantage, "that stack shows what can be done in the way of firing without smoking out the whole town. There isn't what you could call smoke in that, for you can see through it at the top of the stack any place and in about a minute it will almost disappear."

Sure enough, in about a minute the smoke gradually changed to a lighter color, and finally was nothing but a faint haze. Then we went in to see the fire. The Chief opened the doors one at a time and called my attention to the good features and also to some that could be improved.

"But Chief," I asked, "why is it that we do not use so much coal now as we did up to this week?"

"Why?" he mused, "well if you will promise not to let it affect the size of your head, I will tell you. It is because there is a great difference in firemen and Fred isn't one the ones that I can count on my one hand."

Saying which, he left, but it made me feel complimented to hear him say what he did. It was at least pleasant to know that he thought that I could fire better than Fred, although he did not say so in so many words.

So father, I am getting along very well as a fireman and possibly some day, I may be a real one. I am glad that I took your advice and started at the wheelbarrow end, for there is so much to study and to think about. When I was at "Bergville Tech." I thought, wrote and spoke in terms of B.t.u., "from and at," efficiency, evaporation, percentage of combustible, terminal temperatures and all those things, only as something necessary to secure a diploma from the institution. Now I am beginning to realize that all these things are necessary to make not only an engineer, but a fireman as well. Give my love tomother . Affectionately your son.

Donald C. MacDougal.

THE CONDENSATION HOOK

Irregularity of the Compression Curve Due to Low Piston Speed or a Cold Cylinder

IN discussing the effect of low speed in steam engines, Mr. Clayton states that this will cause the compression curve on a diagram to deviate from its normal shape, causing the hook from excessive condensation near the upper end. Such hooks occur usually in small engines having low piston speeds or in larger engines with small clearance and low speed of rotation such as pumping engines.

As an example, in a 12 by 24-in. experimental engine at Liege, running at 30 to 60 r.p.m. a noticeable hook was shown. In the 12 by 24-in. engine used by Mr. Clayton, when run on regular test at 90 to 150 r.p.m. no hook was formed; but with the engine started cold, and brought up to a speed of 120 r.p.m. a decided hook was found, which later disappeared. This would seem to be due to the cold surfaces of the cylinder when starting causing excessive condensation during compression, as the temperature of the steam rose with the pressure.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Concrete Tank

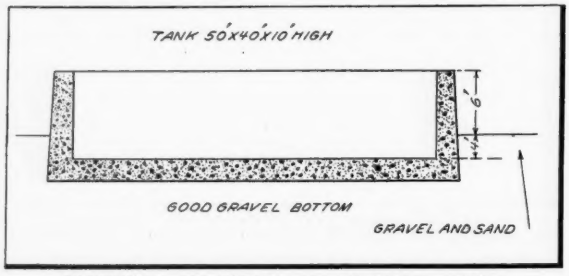
KINDLY give required thickness of wall for a concrete tank with dimension shown in accompanying diagram.

Concrete will be mixed as follows: 1 part Atlas Portland cement, 2 parts sharp sand, 4 parts No. 2 crushed stone. The whole to be machine mixed. The tank will set 4 ft. in the ground.

What should be the thickness of the required wall if concrete is reinforced and what if not reinforced? F. M. P.

A. For the dimensions that you have, after going carefully over the design and the dimensions of some similar tanks, we would recommend as follows:

The gravel bed under the floor should be arranged so that it will drain well to avoid undue water pressure and possible freezing of the ground water in case the tank should be left empty during the winter season. With this done, a floor 4 in. thick of the mixture which you name should be sufficient, but an extra 3 in. of thickness should be used under the side walls all the way around and also sidewise and lengthwise. The width of these underfootings should be 4 ft. The side walls should be 10 in. thick at the bottom and at least 6 in. at the top, better 8 in.



SECTIONAL ELEVATION OF PROPOSED TANK

The reinforcement should consist, for the floor, of ¾-in. rods laid 12 in. on centers each way. For the walls there should be ½-in. rods placed near the inner and outer faces, 2 ft. centers and spacing staggered as between inner and outer faces. The horizontal reinforcement should be ¾-in. rods, 10 in. centers staggered inside and outside and bound to the vertical reinforcement.

The vertical reinforcement should run down and be made fast to the floor rods. The corners should be made with a fillet for both strength and convenience in cleaning out, and every alternate vertical rod on the inside face should be carried at an angle through this fillet and tied to the floor rod, while the alternate floor rods should be bent up through the fillet and tied to the inside vertical. This arrangement should be staggered, as between the 2 side walls and end walls, so that all floor rods will be made with one end bent up in this way, and every alternate vertical should have the bent lower end.

In regard to the plain concrete without reinforcement, this is not advised by concrete engineers, as they claim that the extra weight of concrete needed will cost more than the reinforcement. If no reinforcing is used, the thickness as given should be at least double all around. A. L. R.

Water Pump Problem

WE have a 5,000 gal. per min. pump with the center line of the plunger 13¼ ft. above the water line, that is, having a suction lift 13¼ ft., and pumping against a static head of 125 ft.

What would be the per cent gain in efficiency of this pump if it were lowered so as to bring the center line of plungers to the water level?

What is the rule for this calculation? R. G. H.

A. Work to be done by the pump is elevation of the water, 125+13.25=138.25 feet, and the height of the pump above the surface of the water supply will make no difference in the amount of power required, provided, of course, that the pump is not above the height to which the atmospheric pressure will force the water into the suction pipe fast enough to fill the pump cylinder as the plunger recedes.

It is simply a question of moving a vertical column of water at a given rate of speed, and the point at which the power or force is applied will make no difference in the efficiency of the pump.

F. L. Johnson.

Receiver Pressure

HAVING a cross compound engine with given initial steam pressure and back pressure, a known cylinder ratio, and cutoff at ¼ stroke in H. P. cylinder, how would you find receiver pressure and cutoff in L. P. cylinder that work may be equally divided between cylinders?

2. Give shortest rule to find m.e.p. of compound engine to develop a given horsepower. A. B. R.

A. Take for example, an engine whose cylinders are 15 in. and 30 in. in diameter.

Piston speed=600 ft. per min.

Back pressure, Atmospheric=15 lb. abs.

Cut off H. P. cyl.=¼.

Area H. P. cyl.=177 sq. in. L. P.=707 sq. in.

Initial Steam press.=110 lb. gage.

Initial Thrust, H. P. cyl.=110×177=19470 lb.

Initial Thrust in L. P. cylinder=Receiver pressure

$$= \frac{19470}{177+707} = \frac{19470}{884} = 22.2 \text{ lb. per sq. in.}$$

$$\text{m.e.p. H.P. cyl.} = \frac{P.}{r}\,(1 + \text{hyper. log. } r) - P.$$

$$= \frac{125}{4}\,(1 + 1.3863) - 33$$

$$= 41.6 \text{ lb.}$$

Hp. developed in H.P. cyl.

$$= \frac{41.6 \times 177 \times 600}{33000} = 134.$$

To divide load equally, L.P. cylinder must also develop 134 hp.

$$134 = \frac{\text{m.e.p.} \times 707 \times 600}{33000}$$

$$\text{or, m.e.p.} = \frac{134 \times 33000}{707 \times 600}$$

$$= 10.4 \text{ lb. in L.P. cylinder.}$$

To find cut off L.P. cyl.—Substitute values for r, in the logarithmic formula until proper value is found. (A table of hyperbolic logarithms may be found in almost any handbook).

$$\text{m.e.p.} = \frac{P.}{r}. \ (1 + \text{hyper. log. r.}) - P.$$

$$10.4 = \frac{18 + 15}{r} (1 + \text{hyper. log. r.}) - 15.$$

$$10.4\,r. = 33 + 33 \text{ hy. log. r.} - 15\,r.$$

By substituting 2.5 for r, we have, $62.5 - 30.2 = 32.3$, which is approx. 33.

Therefore the cutoff in the L.P. cyl. would be:

$$\frac{1}{2.5} = .4$$

2. In a compound engine, the m.e.p. of each cylinder is different. The best way to calculate it, supposing the work done in each cylinder is known, is from the horsepower formula,

$$\frac{PLAN}{33000}$$

$$\text{or, } P = \frac{33000 \times \text{Hp.}}{LAN}$$

P = m.e.p.
L = stroke.
A = area in sq. in. of each cylinder.
N = R.P.M.

Cards From a Buckeye Engine

ACCOMPANYING diagrams were taken from a 20 by 40 in. Buckeye engine. I should like suggestions for improvement and to ask if I have the hp. figured correctly as given on the diagrams. J. C. W.

A. Probably the most noticeable defect in these diagrams is a slight indication of wire-drawing of the steam at the beginning of each stroke, as shown by the rounded corners of the steam lines. Admission is prompt, and occurs at the proper moment for both ends, but apparently there is a slight restriction to the free passage of the steam into the cylinder as the piston begins to move. Any reduction of port area below a specified standard is sure to develope a case of wire drawing.

The following is a good rule for figuring steam port area, as both piston area and piston speed enter into the calculation.

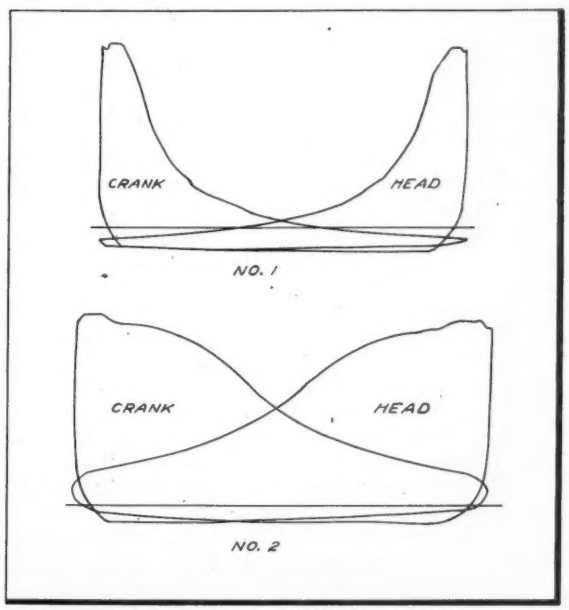
$$\text{Rule: } \frac{\text{Area of port}}{\text{Area of piston}} = \frac{\text{Piston speed per minute}}{\begin{matrix}5000 \text{ for H. P. cylinder} \\ 6500 \text{ " I. P. " } \\ 8000 \text{ " L. P. " }\end{matrix}}$$

If possible these figures should be reduced about 10 per cent. Valve adjustments for compression, lead, cutoff, and release are practically perfect, each of the above named events occurring at the exact time best adapted to the type of engine from which the diagrams were taken. Referring to diagram No. 1, the m.e.p. for the head end is 23 lb.; that of the crank is 22 lb., the average being 22.5 lb.

The i.h.p. as shown by this diagram is 161.8. The following calculation for steam consumption may prove interesting. Allowing a clearance of 4 per cent, the volume of steam exhausted per stroke equals 7.8 cubic feet found as follows: Piston displacement equals area of piston (326 sq. in.) × length of stroke 40 in. =13040 cu. in.; volume of clearance equals 13040×.04=521.6 cu. in. Total volume=13040+521.6 =13561.6 cu. in., which reduced to cu. ft. as follows, 13561.6÷1728=7.85 cu. ft.

This represents the volume of steam exhausted into the condenser at each stroke, and as the engine was running at a speed of 109 r.p.m., or 218 strokes, we have a total volume of 7.85×218=1710 cu. ft. per min.

Absolute terminal pressure, as shown on diagram No. 1 is 10 lb., and the weight of one cubic ft. of the steam at this pressure is .0264 lb. Therefore the



CARDS FROM A BUCKEYE ENGINE

weight of steam exhausted per minute=1710×.0264= 45.1 pounds, and 45.1 × 60 = 2706 pounds weight of steam exhausted per hr., and the steam consumption per i.h.p. per hr. equals 2706 ÷ 161.8 = 17.34 lb.

Diagram No. 2 shows for the head end, a m.e.p. of 50.9 lb., and for the crank end 49.9 lb.; average m.e.p. 50.4 lb.

The i.h.p.=area of piston (326 sq. in.) × m.e.p. (50.4 lb.) × piston speed (680 ft.)÷33000=398.5. The absolute terminal pressure as shown by diagram No. 2 is 26 lb. and a cubic ft. of steam at this pressure weighs .0649 lb. At the time this diagram was taken the engine was making 204 strokes per min., therefore, the total weight of steam exhausted per hr. will be 7.8×204×60×.0649=6183lb. and the steam consumption per i.h.p. per hr. will be, 6196÷338.5=18.3 lb.

This is a very good showing. The point of cutoff is not very plainly defined, but may be considered as

being located at about 28 per cent of the length of the stroke. The total number of expansions is 3.65; found as follows: Absolute initial pressure (95 lb.) ÷ absolute terminal pressure (26 lb.) =3.65.

The engine would make a still better showing if the boiler pressure was increased to 100 lb., or 110 lb. per sq. in., as cutoff could then occur earlier in the stroke, resulting in an increased number of expansions. C. F. Swingle.

Steam Engine Questions

WILL you kindly answer the following questions in your columns?

1. What is the proper length of indicator card from an engine with a 42-in. stroke?
2. What 2 forces are opposed to each other in a flyball governor?
3. Which requires the greater outside lap cutting off at 9/16 in. stroke or at 7/8-in. stroke?
4. Suppose a slide valve cut off at 3/4 stroke and a 5/8 cutoff is desired, how could you proceed?
5. What is the effect of giving inside lap to a slide valve?
6. In an automatic cutoff high-speed engine with a shaft governor, is the eccentric fastened to the shaft?
7. Are all flyball governors throttling governors?
8. How is the proper length of indicator diagram determined for any stroke and how do you find the proper bushing for the reducing wheel?
9. In an ordinary slide valve engine will the valve cut off at the same point in both strokes if it has equal lap and lead? W. E. A.

A. An indicator diagram should be made as long as the speed of the engine will permit without introducing errors from drum inertia, springing of connections, cord whipping, etc. For a speed of 75 r.p.m., or less, 4½ to 5 in. is a good length, while at 300 r.p.m. it may be necessary to shorten the drum travel to 2½ in. in order to get reliable diagrams.

2. Centrifugal force and gravity are opposed to each other in the action of the flyball governor. Centrifugal force tends to throw the balls outward and hence upward as they revolve while gravity tends to hold them down.

3. For the same valve travel, the cutoff is shortened as the outside lap is increased.

4. To shorten the cutoff in a plain slide valve engine, it is necessary to increase the outside lap of the valve.

5. Increasing the inside lap retards release and hastens compression, that is, the exhaust port is opened later and closed earlier in the stroke.

6. The eccentric is not rigidly fastened, but is free to turn on the shaft. Its position in relation to the crank is controlled by the governor.

7. Only those which control the flow of steam to the steam chest or the engine speed by the pressure in the steam chest, are throttling governors.

8. Reducing wheel bushings are usually marked by the makers with figures denoting the stroke of piston for which each is suitable.

9. No. The angle which the connecting rod makes with the center line of the engine affects the position of the piston in the cylinder and causes an earlier cutoff in one end of the cylinder than in the other

F. L. Johnson.

Injectors for Hot Water; Reversed Polarity; Safety Valves

ARE there any injectors or inspirators that will handle hot water?

2. If the polarity of a dynamo changes, that is, if it reverses its polarity, how do you bring it back to its right polarity, or in phase with the second machine.

3. What is the proportion of grate area, in regard to the area of a safety valve of the pop and the lever type. J. H.

A. Injectors and inspirators will usually handle hot water up to about 120 deg. F. Above this the condensation of steam up to the incoming water is not rapid enough to let the apparatus work. Even with water above 100 deg. it is usually necessary to use the inspirator type having one nozzle for lifting the water and another for forcing it, or else to have the water come to the injector from above so that there is no lift.

2. In the case of a dynamo whose polarity is reversed, the best method for handling it, if you have a second machine, is to lift the brushes on the reversed machine and connect the dynamo with the field circuit closed to the busbars. In this way current from the second machine will flow through the fields of the first machine and will again put the polarity in correct direction. Be sure that the brushes on the reversed machine are lifted before connecting the machine to the busbars. Before trying to connect the machine which has been reversed to line, pull the switch to the busbars, lower the brushes, and bring the machine up to speed and voltage, testing the polarity to be sure that it is now in the right direction.

3. The correct area for a safety valve depends on the steam pressure carried as well as on the grate area. At a high pressure a smaller safety valve can be employed than for low pressure. For the ordinary 45-deg. safety valve a good rule is: Diameter required in inches equals 0.0095 times the pounds of steam evaporated per hour, divided by the lift in inches times the absolute boiler pressure. A rule frequently used, known as the Philadelphia rule, is that the area in square inches shall equal 22.5 times the grate area in square feet, divided by the pressure plus 8.62.

Another rule is that the area in square inches shall equal 4 times the grate area in square feet, divided by the square root of the pressure in pounds per square inch.

There is no particular difference between the pop and lever types in effectiveness, but there is some difference in lift. The allowance by the Massachusetts Board of Boiler Rules runs about as follows:

For a 1-in. valve at pressures 25 to 50 lb., 1.75 sq. ft. grate; 50 to 100 lb., 2 sq. ft. grate.

2-in. valve at 25 to 50 lb. pressure, 6.5 sq. ft. of grate; 50 to 100 lb., 7.25 sq. ft. of grate.

3-in. valve, 25 to 50 lb., 14.25 sq. ft. grate; 50 to 100 lb., 16 sq. ft.

4-in. valve, 25 to 50 lb., 25.5 sq. ft. grate; 50 to 100 lb., 28.25 sq. ft. of grate A. L. R.

Steam Pump and Injector Problem

FOR an injector furnishing 942 gal. of water an hour to a boiler carrying 80 lb. pressure, what will be the horsepower required? Also what will be the horsepower needed by a steam pump for the same service and which will be more economical, the steam pump or the injector? G. W.

A. If you refer to the boiler horsepower which will be supplied by an injector delivering the amount

specified, it will be, assuming 30 lb. of water required per horsepower-hour, about 275 horsepower. From the series of curves recently given in the data sheet the steam required per hour is about 510 lb. If you refer to the matter of the power which must be generated by the injector, that is a difficult thing to figure because water from the injector in order to enter the boiler at all must enter at a certain velocity and it is difficult to figure just what velocity it will have to have and the power that would be required.

Experiments have shown that for 80 lb. pressure the ratio of steam required to water forced into the boiler is about 1 to 15, which will give us the means of computing the steam consumption. 942 gal. per hour would be 942 times 8⅓, or 7845 lb. an hour, and the head corresponding to 80 lb. pressure, $80 \times 2.31 = 184.8$ ft. The work required per minute would then be the weight of water times the head, divided by 60, giving 24150 foot pounds a minute, or dividing this by 33,000 gives 0.732 horsepower, which would be the power furnished by the pump. Allowing say, 15 per cent for friction and slip would give 0.842 hp. to be furnished by the steam. A pump of this size would use about 120 lb. of steam per horsepower hour or $0.842 \times 120 = 100.8$ lb. an hour. Dividing 7845 by 15 gives 522 lb. of steam used an hour by the injector. This is offset, however, by the fact that all the heat in the injector steam is returned to the boiler, while with the use of a pump only part of the steam can be saved by using a feed water heater.

As to the relative coal consumption of the two cases, you specify that in both cases cold water should be used at 60 deg. temperature. That means, of course, that no feed-water heater will be used with the pump. To make a pound of steam at 80 lb. pressure with feed water 60 deg. temperature will require in the boiler an amount of heat equal to the total heat of a pound of steam minus the heat in a pound of water at 60 degrees. From the steam tables the total heat in the steam is 1180.7 B.t.u. The heat in a pound of water 60—32 or 28 B.t.u. The difference between these is 1152.7. Assume that a pound of coal will give 13,600 B.t.u and that the boiler and furnace have an efficiency of 70 per cent which is certainly high enough. It makes no particular difference for our problem, because the comparison will use the same efficiency in both cases. A pound of coal will then avoporate $\frac{13{,}500 \times 0.7}{1152.7}$ or 8.2 lb. of water, and to evaporate 7845 lb. per hour will require 7845÷8.2, for 10 hours 10 times this, or 9560 lb. Assuming that this is the amount of steam which must be delivered for net use, we have to provide also 100.8 lb. of steam for the pump, which would require 100.8 divided by 8.2 and multiplied by 10, or 123 lb. of coal per day of 10 hours or a total of 9,683 lb. per day.

For an injector the feed water will be supplied to the boiler about 120 deg. Fahrenheit. To evaporate 1 lb. into steam will require 1180.7—(120—32) which equals 1092.7 B.t.u. Evaporation per pound of coal will then be $\frac{13500 \times 0.7}{1092.7} = 8.66$ lb. of water. The coal required in 10 hours will be $\frac{7845 \times 10}{8.66}$ or 9040 lb. In addition to this there is the steam required by the injector which would be $\frac{522 \times 10}{8.66} = 600$ lb. of coal per 10 hours, total 9640 lb. for a 10-hour day for the injector. Comparing this with the 9683 lb. for the steam pump shows a saving of 43 lb. per day by using the injector or for a year of 300 working days, 12,900 lb. or 6.4 tons. This at $3 a ton would make a saving of $19 a year.

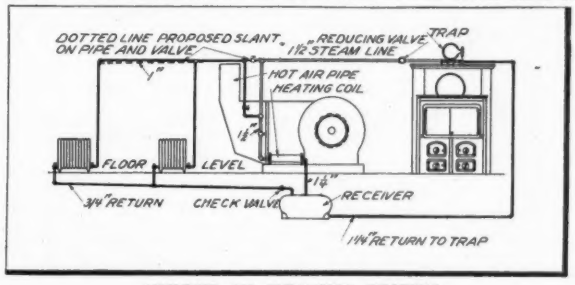
Trouble With Heating System

I HAVE a hot air fan and two radiators for heating a shop; when both are in operation there is a poor circulation on the office line (radiators), but when the steam valve is shut off on the coil in the fan the water and condensation in the radiator line comes rushing through the receiver to the trap on the top of the boiler.

How can I change the piping so when the fan is on it will not affect the radiator line? The size of pipe in shown in sketch. I carry 110 lb. on the boiler and 75 lb. on the heating line. Each return pipe entering the receiver has a check valve on it. The receiver is about 2 feet below the floor level.

L. B. G.

A. Drawing shows quite a water pocket in the one-inch pipe line running to the office radiators, and and when the steam has a straight path through the heater and a good drain to the receiver, the pressure in the receiver would not be much lower than that in the supply pipe and as it is the difference in pressure which causes steam to flow through pipes there could not be a very rapid circulation through the radiators because at the outset there is a water pocket of 4 or 5 ft. which retards the steam to the radiators. Now the remedy for that would be to connect the 1½-in. pipe to the one-inch pipe straight across as marked on the drawing, the valve being on the connection and fitted with a sprocket wheel and chain so that it can be opened and closed from the floor.



SKETCH OF HEATING SYSTEM

If the radiators should be any higher than they are represented to be in the drawing, so that the 1-in. pipe takes another rise, it should be carried up at the point where steam is supplied to the fan heater thus draining the riser and starting the steam supply from the highest point and enabling the pipe to have a steady slant downward all the way to the radiators.

It might be better to carry the pipe to the high point before taking off the connection to the fan heater and then it could be arranged to give the steam to the radiators a straight flow and the fan heater the connection out of the bottom of the pipe, that is, put on a 1½ by 1 by 1½ in. tee, taking the fan heater steam out of the side outlet. The 1-in. pipe should be covered also. If that does not help the matter, try air valves on the radiators.

A water seal of 8 ft. or so, on the return of the fan heater, the top of the seal being below the bottom of the heater, would help if it is possible to get one there.

S. E. Balcom.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

What Kind of a Pump?

WE have a well about 14 ft. in diameter, with platform about 20 ft. from the top, and water stands in the well from 6 to 10 ft. below the platform. The suction pipe is 5 in. in diameter and runs down about 150 ft., and the discharge is 4 in. in diameter and about 50 ft. in length to the tank. The tank is made up of 18 ft. staves and is on a derrick 75 ft. high, so that the entire head is about 125 to 135 ft. The pump is required to throw 150 gal. or more per minute. Both steam and electric power are available. What kind of pump should be used to do the best work?

H. C.

Device for Slotting Commutators

ON page 435 of the April 15 issue of Practical Engineer there appeared a problem from G. E. G. on the subject of commutator sparking and as I have been through several cases of this kind should like to offer my suggestions.

It is evident from the age of the machine that the commutator must be well worn radially. Tighten up the end rings, as far as possible, and then true up with turning tool. Mica between bars should be cut down about 1/16 in. approximately the length of the commutator.

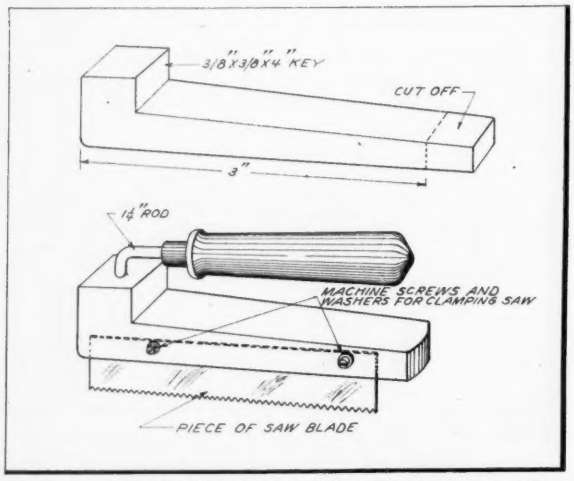


FIG. 1. SAW FOR SLOTTING MICA IN COMMUTATORS

Mica can be cut down with a piece of fine toothed hack saw blade about 2 in. long, after the "set" in teeth is ground off by holding the saw flat against a grindstone. My device is an old 3/8 by 3/8 by 4 in. key arranged as shown in Fig. 1. Handle rod can be bent to suit user and the handle affords grip on the tool and the saw is held stiffly.

By starting as shown in Fig. 2, a little help will be gained by providing a partial guide for the saw blade. A firm even stroke across the commutator can be taken with a little practice. Hold the saw down firmly and push slowly ahead under control so that if saw jumps out you will score the copper a minimum amount. After the first strip is cut out take a piece of saw blade with "set" still in and go through cuts and remove the thin mica left sticking to the sides of the bars.

A guide can be employed with this cutter by using bolts to hold the saw blade and under the heads of bolts on opposite side of key inserting a saw blade

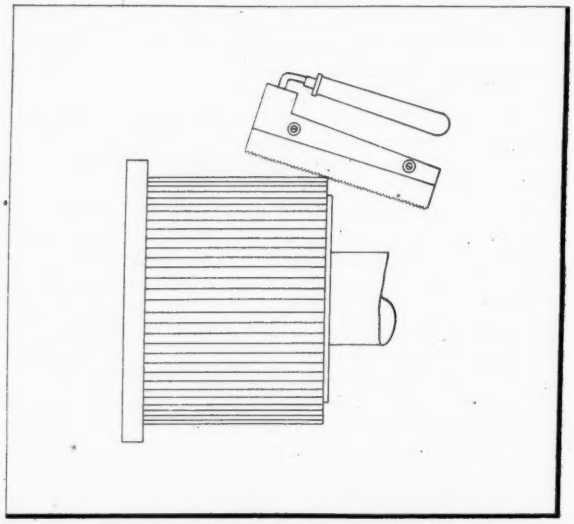


FIG. 2. HOW THE SAW IS APPLIED

smooth edge down. File the key to right thickness and get smooth edge in a cut and other blade over an uncut strip and use as before. I have found, however, that this guide is troublesome and does not help much.

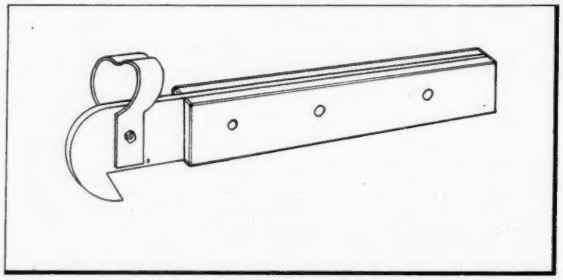


FIG. 3. HOOK FOR SLOTTING BETWEEN SEGMENTS

A hook made as shown in Fig. 3, can be used in places where a saw cannot be used. Soften a blade, file a hook on one end as shown and rivet wood strips on each side of blade to form a handle. Through the pin hole in the end place a small bolt to hold a piece of bent tin forming a finger rest. Draw the hook

across the mica, starting at about one in. from the outer end of the commutator and pull off a little mica, then go back further for another stroke until the surface is below the copper, then you can take a new full length stroke and slot is done.

Mica is so much harder than the hardest copper that even a turning tool will not cut it off flush with the surface of the commutator. C. M. Green.

Sparking Commutator, Babbitting Brasses

ON page 435, April 15, 1912, issue of Practical Engineer, G. E. G. asks for a solution and remedy for a sparking generator. I had the same difficulty with a 4-pole 1600 r.p.m. 110-v. direct-connected dynamo, and found that the trouble was due to an unbalanced armature core casting, which produced vibration and in turn caused the brass boxes to wear. This allowed the shaft to jump up and down, causing the commutator to move away from 2 of the brushes once each revolution.

Putting in new brasses, or rebabbitting, will remedy the trouble so that if the new boxes are as tight and of as good wearing material as the old ones were, the generator will give good service for the same length of time.

Eventually, however, the trouble will reappear, and the only permanent remedy is to balance the armature, shaft and pulley together, using knife-edge supports at bearing points on shaft and adding weight to the light half until the armature, shaft and pulley will stand on the knife-edge supports with any coil or commutator bar up.

Weight to be added can be of lead held in place on the inner face of the armature core casting by one or two small set screws.

In answer to J. F. McI. on page 434, April 15, issue of Practical Engineer, I would say that when babbitting crank brasses or boxes in place, spread the brasses as far apart in the strap as possible with wedge, if there is one, in place and loosened. This allows the greatest thickness of babbit between the crank-pin and box. Then measure the length, breadth and thickness of the space between the crank pin and brasses to find the cubical contents which it is required to fill with babbit.

Piece of babbit containing the same number of cubic inches will fill this space. You should, however, put into the ladle at least one-tenth more babbit to make up for shrinkage and any that may be spilled and also to fill in the anchor holes which should have previously been drilled in the brasses to a depth equal to the thickness of the space to be filled. There should be 4 5/8-in. holes in each half of the brasses. J. H. L.

Voltage Drop of Generator

IT is well known that a generator attains almost its maximum temperature after 2 or 3 hours. Every generator should have a resistance or regulator in the field circuit, which is gradually cut out as the machine warms up.

One simple way in which he could overcome his trouble would be to run his generator to a higher speed, and put a regulator in the shunt circuit, and gradually cut out till he gets his required voltage, at commencement of run, and also as machine warms up, otherwise he would have to have fresh windings on the field spools, since, if more wire of the same kind was wound on, it would reduce the current, the ampere turns would remain the same, but of course the heating would be much less, yet still he would have the same trouble, only in a lesser degree.

Another way in which the trouble might be overcome would be to put some sheet iron, say .25 mm. thick, underneath all main poles, and thus reduce the gap and increase the flux, and running at the same speed as at present, with a shunt regulator.

The cause of the 20-volt drop is entirely due to increase of resistance as the machine warms up.

S. H. C.

Explanation of Pump Troubles

IN regard to E. J. W.'s pump trouble described in the March 1st issue, there is an obstruction in one of the lines, the pump doesn't get steam enough to move quickly against the 100 lb. pressure, or it doesn't get rid of the exhaust fast enough. A good way to feel for these things is; open the cylinder drain cocks and by observing the escape of steam through them you can judge pretty closely whether or not the steam is being taken and exhausted correctly. Those mechanics probably left a large chunk of waste in an opening where they had put it to keep out dirt and chips when you had the pump down repairing it.

If N. F. S. will connect his heater so that it will be between the pump and boilers on the feed line he will eliminated the pounding of his chick valves. But if the heater is open and this connection cannot be made, I would take out both checks and put in a 2-in. check in the line between the tee and ell in the upper horizontal part of the line if I knew that the pump was in good condition. Locating a 2-in. check as stated would not be out of order, since it would serve either boiler separately or both boilers together, and in the latter case would have the additional advantage of balancing and give less chances for the checks to slam.

The reason why the checks pound is this: the feed entering the pump is probably at a temperature of 190 to 210 deg. F., and under a head of possibly 10 ft. or $10 \times 0.434 = 4.34$ lb., or 19.04 lb. absolute. At this temperature and pressure the liquid is considerably expanded and consequently is capable of being reduced considerably in volume by compression. Also the delivery valves may be leaking considerably, and from these we observe that the stroke of the piston is well advanced before sufficient force or pressure is created in the feed line to open the checks, then when the end of the stroke is reached the flow suddenly stops and the checks slam shut, the inertia of the liquid not being sufficient to continue the flow for a fraction of a second so as to allow the checks to close quietly; then as before, the delivery valves of the pumps may be leaking, which would aid in slamming the checks. These analyses of the situation, I think, are borne out by the fact that the checks do not pound when the pump is run slow. We assume that they are clean and in good condition, which they must be to work well, even if other conditions are favorable. Thos. C. Robinson.

Trouble With Ammonia Compressor

REFERRING to the trouble with ammonia compressor packing described on P. 213 of Feb. 15 issue, the engineer has overcome his trouble as per the explanation given in the last paragraph on the page by having the packing cut out to fill the boxes rather than have an allowance as he had been doing. A set of gages was made for the size packing required, and that was sent to the packing manufacturer who fitted the rings in these gages before shipping, and there has been no trouble since.

C. S.

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ENGINE TESTS BY THE INDICATOR

In an earlier issue, attention was called to a remarkable extension of the field of usefulness of the steam engine indicator by the analysis of the diagram. In the issues of May 15 and the present is given a synopsis of this method and the outline of its use. It will well repay all the time and study needed to master it in detail.

While it is a little more complex than the use of the diagram for valve setting and figuring horsepower, it does not involve any complex formulas, and is not more difficult than figuring a boiler test. Knowledge of the steam table is needed, and, as always in computations, the slide rule comes in handy in saving time and labor.

Plotting the diagram on logarithmic paper is the most unfamiliar of the processes, but the only real difficulty is in estimating the intermediate distances between lines in transferring lengths and pressures from the diagram to the logarithmic sheet. Against this slight labor are to be placed the advantages of ready determination of steam consumption by each end of the cylinder, events of the stroke, leakage of valves or piston, clearance volume.

To get these values has heretofore required a series of weighings and test readings, cutting the engine out of service, and partial taking down of the cylinder and valves; and at the end, almost as much computation as by the Clayton method.

As to accuracy, for all values except steam consumption, the correctness of determination seems greater than by methods previously used; the steam consumption checks within 2 per cent with weights from condenser readings, and this variation is not larger than is found between different tests of a given engine running under apparently the same conditions on different days.

In the next issue we shall show the method of working out one of the sets of diagrams from the engine tests given in this issue, with full explanation of each step and comparison of values by the Clayton method with those by direct test.

CONVENTIONS OF DIFFERENT engineering associations are now in order to follow each other rapidly, and the following list will be of interest to those who wish to attend:

May 29-31, American Society of Mechanical Engineers, Cleveland, O. May 30, June 1, New Jersey State Association, Stationary Engineers, at Newark. June 3-8, American Order of Steam Engineers at Allentown, Pa. June 7-8, Pennsylvania State Association of Engineers at DuBois. June 6-8, Indiana State Association at Evansville. June 13-15, Kentucky State Association at Owensboro. June 20-22, Missouri State Association at Joplin. June 17-22, National Gas Engine Association at Milwaukee. June 27-29, Iowa State Association at Sioux City. June 28-29, Connecticut State Association at Bridgeport. July 11-13, Massachusetts State Association at Northampton. July 17-20, Minnesota State at Winona. July 24-27, Wisconsin State at Racine. Aug. 1-3, Michigan State Association at Flint. Aug. 6-10, Universal Craftsmen's Council national convention at St. Louis. Sept. 9-13, the National Association of Stationary Engineers at Kansas City, Mo.

UNWISE ECONOMY IN SHAFTING

Power Loss May Be More Than First Cost

PUTTING a 24 by 8-in. pulley on a 2-in. shaft, midway between bearings, 8 ft. on centers, would not be an unusual arrangement. Such a shaft is commonly rated at 10 hp. at 100 r.p.m. and the pulley should transmit 9 hp. at 100 r.p.m. with a double belt.

Test Apparatus

IN order to determine the wisdom of such an arrangement, experiments were made in the laboratory of the Dodge Mfg. Co., results of which are given by Karl W. Knorr in the Dodge Idea. The illustration shows the method of arrangement. Two drop hangers were inverted so as to act as floor stands and mounted on heavy steel beams in the form of a frame. The longest distance which could be secured was 7 ft. 9 in. between bearings.

In these bearings a piece of 1 15/16-in. shafting was placed, long enough to overhang one of the bearings a few feet and with collars on the shaft next to the bearings to prevent endwise movement. Midway between the bearings a 24 by 8-in. standard cast-iron split pulley was flanged to the shaft so that it could not turn and an 8-in. double belt placed over it with ends hanging down some 2 ft. from the center of the pulley. The belt was pliable and got a good grip on the pulley. Rope slings were attached to the ends of the belt with rods to carry the weights needed in loading.

On the overhanging portion of the shaft a 72-in. wood pulley was placed to be used in turning the shaft when weights were applied to the belt on the central pulley.

Method of Loading

AS effective tension or pull, that is, difference between the tension on the 2 sides of the belt, 60 lb. per inch of width is allowed by most manufacturers of leather belting; of course, the total pull on the tight side is much greater. For an 8-in. belt this would give a total effective pull of 8 times 60 or 480 lb., and this amount was put on one of the weight rods.

When weights were applied on the other rod, the shaft was turned by means of a large wood pulley in the direction to lift the 480 lb., and the central pulley revolved without moving the belt. In order to lift the 480 lb. of weight, additional weight was placed on both rods in equal amounts until turning the shaft by means of the large wood pulley would just lift the 480 lb. weight. There was considerable additional weight on top of the 480 lb., but this was balanced by an equal amount of weight on the other end of the strip of belt.

Deflection Shown

CAREFUL measurement showed that under these conditions the deflection of the shaft at the center was 9/16 in., which is obviously more than one would care to deflect a 2-in. shaft.

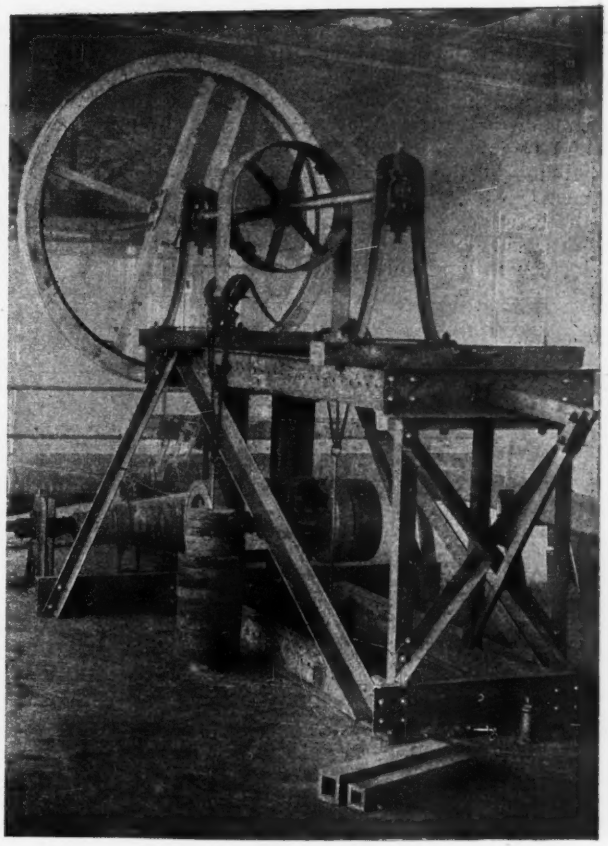
A greater effective pull than this, which is not uncommon in many factories, would of course produce a still greater deflection of the shaft. Of course, shafts are run under these conditions, but it is evident that with such deflection the amount of friction on the bearings and the power expended in springing the shaft as it revolves would be more than sufficient to pay the cost of a heavier installation.

Three ways are possible for preventing such a dedeflection: The use of larger shafting; reducing the distance between bearings where pulls are heavy; and reducing the belt pull. The method of figuring the size of a shafting is given in the January 1911 issue so that analysis can be made on the proportions for any arrangement as indicated.

To Reduce Deflection

BY placing an extra bearing alongside the pulley in the test already mentioned, the greater portion of the belt pull would have been carried by this bearing and the deflection reduced to practically nothing. This amounts to a reduction of distance between bearings.

In order to diminish belt pull, the best means is to use pulleys of large diameter as in this way the same power can be transmitted with a less belt tension on account of the higher belt speed. This not only saves



APPARATUS USED BY THE DODGE MFG. CO. IN TESTS OF SHAFT DEFLECTION

in pull on the shaft but also in friction on the bearings and in cost of the belt, as a narrower belt can be used with the lighter belt pull.

From the commercial standpoint the belt situation may be expressed briefly: 1. Don't put in shafting too light for the service. 2. Don't economize by putting up an insufficient number of bearings. 3. Don't be careless about the kind of bearings you buy. 4. Don't try to cut first cost by buying pulleys of small diameter with wide belts instead of pulleys of large diameter for narrow belts. 5. Don't think that you will save money by putting up shafting that is not what it ought to be; for power costs will be greater than interest saved.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

GOULDS CENTRIFUGAL PUMPS

A Single Stage, Double Suction Pump of Compact Design

THE most important detail of construction in the centrifugal pump is the rotating element or impeller. In the Goulds Double Suction pump, this part is made up of a series of vanes cast integral with retaining disks on either side and has openings arranged so that the water is led to the inner ends of the vanes. Water is picked up by these vanes and rapidly accelerated until it reaches the circumference of the impeller where it is discharged, the energy which is imparted to the water, appearing in the form of velocity. It is the purpose of the volute water chamber to reduce this velocity gradually thereby converting velocity into pressure.

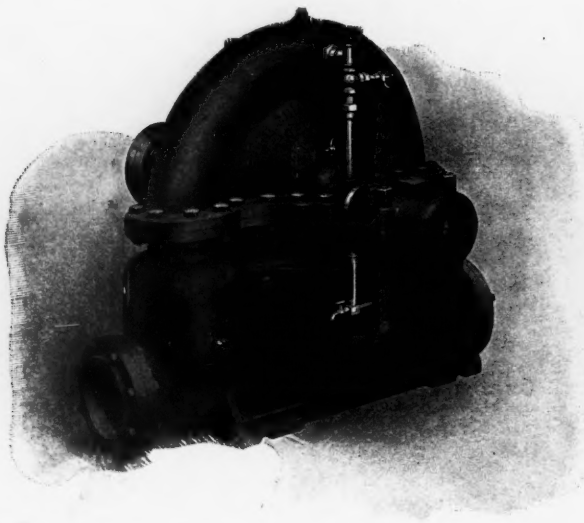


FIG. 1. SIDE VIEW OF THE GOULDS CENTRIFUGAL PUMP

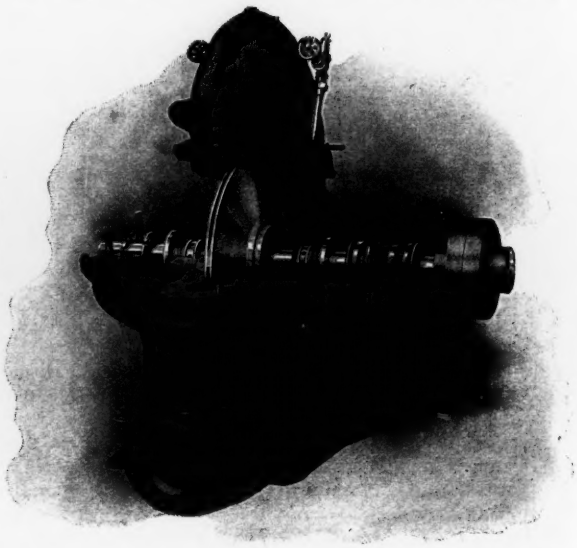


FIG. 2. GOULDS CENTRIFUGAL PUMP WITH COVER RAISED SHOWING IMPELLER AND BEARINGS

Double suction, so aranged that the water is drawn in at both sides at the center, with the 2 streams directly opposite, gives hydraulic balance and prevents end thrust.

The velocity of water at all points from the inlet to the outlet of the impeller is properly controlled to obtain high efficiency under normal service conditions. The design of the impeller and other parts of the pump is such that, as shown by the characteristic curve of capacity and pressure, it is impossible to overload the motive power seriously under any conditions, at the specified speed.

The casing proper is divided horizontally to permit quick and ready access to the interior parts of the pump when necessary, the 2 separate castings being bolted together; great care is taken to design these with uniform section of metal, thus avoiding undue cooling strains and securing maximum strength. The casing is provided with openings for air vents and for attaching pressure gages.

Halves of the casing are accurately doweled for exact alignment, and an oiled paper gasket secures water-tight joint.

The bearings are ring oiling, mounted in housings bolted to the lower half of the pump casing. The bearing housings are rigid brackets which form drip pockets for the stuffing boxes, and are provided with removable shells, lined with antifriction metal, bored and scraped to fit the shaft.

Stuffing boxes through which the shaft passes are provided with brass water sealing rings, to which water at the working pressure of the pump is supplied by means of suitable piping from the upper half of the pump casing. This construction prevents air being drawn into the pump at the stuffing boxes and impairing the suction. At the highest part of the pump casing opening is provided for the purpose of priming the pump, and suitable openings are also arranged at the bottom of the casing for draining.

Before leaving the factory the pump is completely assembled, the working parts properly adjusted and the clearance checked. The discharge and suction openings are then blanked and the pump is subjected to hydraulic pressure much in excess of that which it will be called upon to withstand in service. Where possible, a running test under working conditions is also made at the company's laboratory, and the result of this test is furnished the purchaser, if he desires it.

FALLS AUTOMATIC ENGINE STOP

FALLS automatic engine stop consists of a valve to be placed in the steam line, generally in a vertical position, on top of the engine trottle valve, though, it is also made or adapted for horizontal steam mains.

This valve can be automatically closed either by the hand stop station or the operation of the speed limit device. The speed limit device is so arranged as to close an electric circuit in the electrical apparatus or pull a wire cable in the mechanical apparatus upon the engine's attaining any predetermined speed which shall be the limit of increase of speed desired. As soon as the engine passes this limit the speed limit will immediately operate, closing the valve and shutting down the engine.

General form of this valve is that of a standard extra heavy cross with heads on 2 of the diametrically opposite outlets, a rotary Corliss type of valve with stem projecting through the front head and having a bearing on a bronze pin integral to the rear head. Inside of the valve casing there is a curvilinear seat presenting an oblong opening and bored on the true center of the valve.

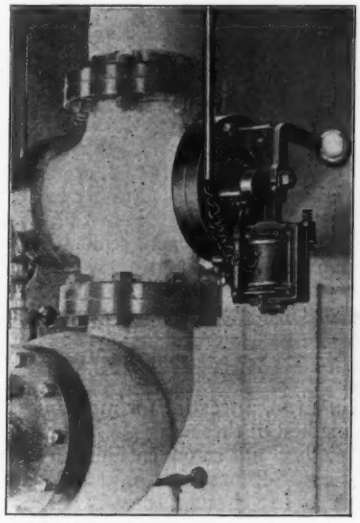
Valve proper consists of a curvilinear plate with approximately triangular end wings. The curvilinear portion of the valve is turned off and finished to fit the face of the valve seat. In the rear end wing is a circular hole which fits over a bronze bearing pin in the rear head. In line with this and in the front end wing there is a square hole fitting over the squared end of the bronze valve stem and passing through a stuffing box in the front head is off-set from the true center of the valve. By this means the valve proper when in the closed position is concentric with its seat, but in revolving to the open position, moves in an excentric line of travel causing it to lift off from the seat, traveling in the steam space, and not coming in contact with anything at any point. In the open position the valve is suspended in steam space.

On the end of the stem, projecting through the front head, there is a valve lever of right-angled form having a spherical weight on its upper end and integral therewith. The lower end of this lever is in the form of a detent in which fits a lever lock roller having bearing in the end of the lever lock proper. This lever lock is fastened to the front head by means of a lever lock stud and is free to rotate thereon. The roller is held in constant contact with the detent of the lever by the weighted end of the lever lock diametrically opposite the roller which greatly over-balances the roller end.

When in the open position the weight of the valve, lever, and weight, present a right angled thrust on the lever lock stud, being held securely in the open position.

Fastened to the lever lock and extending out therefrom is what is known as the lever lock extension which consists of a steel bar. The extreme end of this lever lock extension passes through a slot in the solenoid plunger the solenoid plunger being attached by means of a right angled bent stud to the front head. In the normally open position, this being with solenoid coil dead or unenergized, the plunger is held up by means of the plunger spring in tension.

Operation of this valve is simple. Upon closing of the electric contact either by means of the operating of the over speed device or by the throwing in of one of the shop switches, the solenoid coil becomes energized the magnetic pull attracting the solenoid plunger downward. This strikes the lever lock extension a sharp blow, carrying it down with it by this means rotating the lever lock on the lever lock stud. The roller end of the lever lock is thus pulled out of contact with the lever detent by the force of gravity causing the lever and valve to drop, shutting off the steam line. The jar caused by the falling of this weighted lever is taken up by the jar absorber which consists of a heavy stud, one end attached to the front head, the other being cylindrical in form, a stiff spring projecting through the top of this cylindrical end so that the lever comes in contact with this spring before



FALLS AUTOMATIC ENGINE STOP

the valve reaches the closed position. By this means the final closing is done by the steam pressure on top of the valve forcing it to its seat against the compression of this jar absorber spring. The height of this jar absorber spring is adjustable by means of a threaded plug and jam nut screwing into the cylindrical end.

Valve is equipped with a by-pass cast integral with the valve casing. This is for the purpose of counterbalancing the pressure of the steam on the inlet side of the valve after it has closed.

Falls Engine Stop is manufactured by Falls Machine Co., Sheboygan Falls, Wis.

W. E. RICHARDSON, of the Richardson-Phenix Co., Milwaukee, died at his home in that city on Wednesday, May 15. Further details are not forthcoming at present but will be given later.

CONSOLIDATION IS ANNOUNCED of the B. F. Goodrich Co. and the Diamond Rubber Co., both of Akron, O., the former buying out the latter for $45,000,000. The new Goodrich Co. will be in charge of B. G. Work, president and the offices may be moved to New York City.

A. S. CAMERON Steam Pump Works has removed its factory from New York City and the main office is now located in the Bowling Green Building, 11 Broadway, New York, to which all correspondence should be addressed. The room number is 1631 and the telephone number Rector 8748.

SPENCER C. NEEMES

MR. NEEMES died suddenly at his home, 150 Pawling Ave., Troy, N. Y., on April 29. The event was sudden, as Mr. Neemes had only just returned from a business trip and had been in the house but a few minutes when he complained of indigestion, and although medical aid was summoned immediately, Mr. Neemes was dead on the arrival of the physician.

Mr. Neemes' career has been closely connected with the power plant field. He came to this country from England in 1856 when one year old, and his family located in Albany, in which vicinity he has always lived. His education was in the high school and business college of his adopted city; later he entered the lumber business, and 38 yr. ago removed to Troy, N. Y., where with his father and his brother a foundry business was established under the name of Neemes Bros., which has been carried on since, devoting itself largely to the manufacture of special castings, such as boiler grates and furnaces. Mr. Neemes was prominent in the social life of Troy, member of a number of fraternal orders, the chamber of commerce, and of clubs and religious organizations. The success of the business was due largely to the mechanical skill and inventive capacity of Mr. Neemes and his brother Joseph, one recent achievement being the manufacture of the largest boiler grate ever made which was installed last year as part of the equipment of the American College for Girls at Constantinople, Turkey.

BOOK REVIEW

LATHE GEARING, a treatise for mechanics and apprentices on the method of threading gears for cutting threads of different pitches in a screw cutting lathe, gives dimensions of threads of different pitch, including pipe threads, and instructions for chasing threads without a backing belt, for chasing double and triple threads and for calculating speed of gears or pulleys. The author, W. F. Smith, 1158 W. Hamburg St., Baltimore, Md., states that he has a matter of 200 copies of this treatise which he will be glad to send to Practical Engineer readers who reply within 30 days and enclose 10 cents to pay the cost of printing and postage. Mr. Smith is furnishing these at cost price for the benefit of our readers and cannot fill orders for more than 30 days, as the treatise will not be reprinted.

STEAM POWER PLANTS, Their Design and Construction, by Henry C. Meyer, Jr., M. E., 217 pages, 6 by 9 in., bound in cloth. Price $2.00 net. New York, McGraw-Hill Book Company. This book was written primarily for the benefit of engineers and others in charge of a manufacturing business, be it a mill, factory or electric generating station, who are called upon to design and purchase a steam power plant or parts of it when their knowledge of the machinery that goes into such a plant is more or less limited. This book will be found especially valuable where the benefit of the advice of a competent mechanical engineer is not available. It is fully illustrated with diagrams and halftones of modern plants.

HOUSE WIRING, BY THOMAS W. POPPE. New York, 1912, the Norman W. Henley Publishing Co., 100 pages, price $0.50. This book is intended primarily for those persons who are desirous of obtaining a practical knowledge of the installation of electric lighting systems.

Practical examples of work are included and the subject is treated in a clear and non-technical manner. It will be found a valuable help not only to the experienced electrician but to the beginner as well.

KNOTS, SPLICES AND ROPE WORK, by A. H. Zerrill. One hundred pages fully illustrated and with complete index, in cloth binding, price 60 cents.

In this treatise are given complete and simple directions for making useful and ornamental knots in common use, for splicing rope and putting in eyes, for making loops and hitches, and for pointing, seizing and wrapping. Full and complete illustrations show exactly how each operation is performed and full explanation tells uses to which each rope and splice is best adapted. It is a book well worth while for all who have to use or handle ropes for any purpose.

BRAZING AND SOLDERING, by Jas. F. Hobart, is No. 5 of a series of practical papers issued by the Norman W. Henley Publishing Co., of 132 Nassau St., New York, the price being 25 cents. The book shows how to make a brazing furnace, how to braze with a torch or with charcoal blocks, and how the process is performed by use of any equipment. The subject of soldering shows how to handle the iron properly, how to prepare a joint for soldering by scraping and cutting, and how to get a good start. It also gives special instructions for electrical soldering for handling tin plates, galvanized iron and zinc, lead, lead pipes, aluminum, and the composition of solders suitable for different purposes.

HAND FORGING and Wrought-Iron Ornamental Work, by Thomas F. Googerty, 197 pages, 5 by 8 in. bound in cloth. Price $1.00. Chicago, Popular Mechanics Co. While this book deals largely with interior iron work, it shows also construction principles and methods which underlie all forge work. It is profusely illustrated with designs and methods of manipulating the metal and gives complete instructions for working out many patterns.

MIAMI STEAM TURBINES, by Dr. G. Bauer and O. Lasche, large octavo, 214 pages, bound in cloth. Price $3.50 net. New York, The Norman W. Henley Publishing Co. The book is essentially practical and discusses turbines in which the full expansion of steam passes through a number of separate turbines arranged for driving two or more shafts as in the Parsons system, and turbines in which the complete expansion of steam from inlet to exhaust pressure occurs in a turbine on one shaft, as in the case of the Curtis machine.

The book will enable a designer to carry out all the ordinary calculations necessary for the construction of steam turbines, hence it fills a want which is hardly met by larger and more theoretical works.

Numerous tables, curves and diagrams will be found which explain with remarkable lucidity the reason why turbine blades are designed as they are, the course which steam takes through turbines of various types, the thermodynamics of steam turbine calculation, the influence of vacuum on steam consumption of steam turbines, etc.

HEAT AND THERMODYNAMICS, by F. M. Hartman, New York. McGraw-Hill Book Company. Price $3.00, 346 pages, 6 by 9 in., cloth binding, stiff covers.

This book is intended to supply the demand for a text in teaching the subject of thermodynamics, which properly covers, without introducing too much material, the fundamental principles of heat measurements. Long and tedious descriptions have been avoided and the pictorial illustrations are diagrammatic as they are considered of greater value than photographs.

The book is divided into 2 general parts, as the name implies, the first part covering the subject of heat and the second part thermodynamics, from fundamental principles to practical applications, such as compressed air, refrigeration and steam turbines.

THE NEW YORK AIR BRAKE SYSTEM, compiled and edited by leading air brake experts, Chicago, Frederick J. Drake & Co., 374 pages, 5 by 8 in., cloth, stiff covers.

Complete treatise containing detailed descriptions and explanations of the various parts of the New York Air Brake. In addition there is a complete course of catechetical instruction on all matters connected with the construction, care and operation of the modern air brake.

THE WESTINGHOUSE AIR BRAKE SYSTEM, compiled and edited by air brake experts, Chicago, Frederick J. Drake & Co. This book covers the Westinghouse air brake in a manner similar to the treatment of the New York Air Brake.

MODERN AMERICAN TELEPHONY IN ALL ITS BRANCHES, edited by Arthur Bessey Smith, E. E., Chicago, Frederick J. Drake & Co., price $2.00. 790 pages, flexible leather binding, 4 by 7 in.

Much valuable data has been incorporated in this book. Although it would be practically impossible to treat the whole theory, science and art of the telephone in one volume, this work will be found comprehensive in every respect, and an aid to the engineer as well as to the student. The text is brought up-to-date and includes automatic and wireless telephony.

ENGINEERING AS A VOCATION, by Ernest McCullough, New York, David Williams & Co., price $1.00, 201 pages, 5 by 8 in., cloth bound, stiff covers.

This book was written by a civil engineer of more than twenty-five years' active and varied experience. It is not in the slightest degree pessimistic but is the work of a man anxious to tell the truth about the business of the engineer.

The author seems to believe that if the truth about compensation of engineers and the conditions surrounding their work known to the freshman engineering classes would be much smaller than they are at present. He also seems convinced that the old classical courses in colleges are out of date, and that the only college course to take is an engineering or legal course; but that the graduate should not because of having pursued these studies, necessarily practice either of these professions. They are merely modern educational ideas of adequate preparation for a life of service.

CATALOG NOTES

HANDY DATA on power pumping for the convenience of power pump users is provided in Bulletin No. 112 issued by The Goulds Manufacturing Co., Seneca Falls, N. Y. This bulletin and many others equally useful are cataloged in a postal booklet from which the engineer may select those suited to his needs.

MORSE CHAIN COMPANY, Ithaca, N. Y., has sent us Bulletins 9, 10 and 11, which illustrate and describe many varied applications of the Morse Silent Chain. The bulletins are artistically printed and contain much information of value.

FROM THE STERLING MACHINE CO., Norwich, Conn., we have received Bulletin 106 describing the Sterling Double System Pump, for use in connection with continuous oiling systems.

This pump is designed for drawing the oil from the well or base of the engine and pumping it to the filter. After the oil has been filtered and cleaned, the other end of the pump draws it from the filter and forces it to the overhead storage tank or reservoir, from whence it flows by gravity to the various bearings of the unit to be lubricated.

FROM KELLY FOUNDRY & MACHINE CO., Goshen, Ind., we have received Catalog "B" illustrating and describing Kelly rocking, dumping and stationary grates. This company manufactures a great variety of cast iron appliances for power plant purposes.

INGERSOLL-RAND CO., 11 Broadway, New York City, N. Y. Bulletin form 7004, 12 6 by 9 pages, descriptive of Cameron steam pumps. This pump has fewer working parts than any other steam pump made. The steam mechanism consists of 4 stout pieces only, none of them delicate, intricate or exposed to injury. The operation of this mechanism is such that while under full pressure of steam, the suction pipe may be lifted out of the water, and the pump allowed to run away or race as fast as steam will drive it, without danger of the piston striking the heads or any injury to the pump. The advantage of this can scarcely be exaggerated, since, under most conditions, any pump is liable to have its supply of water cut off unexpectedly.

Steam valve movement works in line with the piston rod without the intervention of arms or levers. The pump can therefore be run without danger of breaking, at a greater speed than any pump employing an outside valve movement. This pump cannot reverse until it has completed its full, honest stroke; it can also be taken completely apart without disconnecting any of the pipes.

Catalog shows the different styles manufactured, and gives tables of sizes and capacities together with price.

N. T. C. BULLETIN No. 9 has been received from the National Tube Co., Pittsburgh. This bulletin entitled "Some Tests of 'Kewanee' Unions" gives details of the exhaustive tests to which these unions are subjected before shipment. Details of a test of various sizes of unions are also given. The unions were connected to a length of pipe and subjected to 140 lb. steam pressure for from 5 min. to 92 hr., after which they were immersed in water at 45 deg. F., for about 30 min. When the pipe is again connected to the steam main and the water boiled out.

BULLETIN 103 JUST ISSUED by the Uehling Instrument Company, of Passaic, N. J., is devoted to their line of CO_2 Meters and Waste Meters. These meters consist of machines for measuring pneumatically either CO_2 or both CO_2 and temperature.

This bulletin describes in concise manner the CO_2 and waste meters and the recorders and indicators which are combined in different ways to form different styles of CO_2 and waste meter equipments.

COMBUSTION AND THE COST OF POWER is the title of a 36-page booklet just issued by the Uehling Instrument Company, of Passaic, N. J. This booklet contains a considerable amount of information concerning combustion and boiler efficiency with particular reference to how high boiler efficiency may be maintained by the use of Uehling CO_2 meters and waste meters.

AMERICAN INJECTOR COMPANY, Detroit, Mich., has issued a new catalog No. 27, describing U. S. automatic injectors, ejectors, jet pumps, drive well jet pumps and many other devices.

HERMAN BACHAROCH of Pittsburgh, has issued a set of bulletins describing his Hydro recording and indicating meters.

BULLETIN No. 60, of the Industrial Instrument Co., Foxboro, Mass., describes its line of indicating gages for all purposes.

ECONOMIC LUBRICATION and Death to Friction are the titles of two interesting little booklets, dealing with lubrication, which have recently been issued by the Albany Lubricating Co., New York.

FROM THE INGERSOL RAND COMPANY, New York, we have received bulletins Nos. 4111 and 4204 descriptive of its "BC" hammer drills and "Arc Valve" tappet rock drills.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa., are issuing a 140 page book on the subject of Cochrane Heaters, describing their use in steam power plants for heating and purifying water, for boiler feed and other purposes.

CATALOG NO. 199 has been received from the Buffalo Forge Co., Buffalo, N. Y., on the subject of Conoidal fans. The Buffalo "Conoidal" fan derives its name from the prevalence of conical shapes in its design. The inlet is conical; the blast wheel forms the frustrum of a cone; and the blades are curved over the tapering surface of a cone. The catalog fully illustrates and describes this type of apparatus.

A FOLDER ISSUED by the C. W. Hunt Co., of West New Brighton, N. Y., shows different types of coal tubs, coal chutes and screens and the method of installing these in various types of coal handling and storage plants.

DEPARTMENT OF THE INTERIOR, Bureau of Mines, in a recent list reports the following publications ready for distribution: Use of permissible explosives, by Clarence Hall and J. J. Rutledge. 1912. 34 pp. 5 pls. Steaming tests of coals and related investigations, September 1, 1904, to December 31, 1908, by L. P. Breckinridge, Henry Kreisinger, and W. T. Ray. 1912. 380 pp. 1 pl. Methods of analyzing coal and coke, by F. M. Stanton and A. C. Fieldner. 1912. 21 pp. Liquified products from natural gas; their properties and uses, by I. C. Allen and G. A. Burrell. 1912. 23 pp. The use of birds and mice for detecting carbon monoxide after mine explosions and fires, by G. A. Burrell. 1912. 14 pp. Tests of run-of-mine and briquetted coal in a locomotive boiler, by W. T. Ray and Henry Kreisinger. 32 pp. Reprint of United States Geological Survey Bulletin 412.

The Bureau of Mines has copies of these publications for free distribution, but can not give more than one copy of the same bulletin to one person. In asking for publications please order them by title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

TWO NEW NATIONAL SPECIALTIES, the National direct-contact feed-water heater and purifier, and the National horizontal oil separator are described in well prepared bulletins recently received from the National Pipe Bending Co., of New Haven, Conn. Each one shows full illustrations and details of operation, and in the oil separator catalog list of general dimensions is given to permit of allowing for the space needed in a piping system. Copies of the bulletins may be had by writing to the company direct.

THE GENERAL ELECTRIC COMPANY has just issued a bulletin, No. 4927, which describes the manufacture of that Company's Feeder Voltage Regulators. It illustrates the various processes of the manufacture and shows the facilities possessed by this company at its Pittsfield works for the manufacture of this type of apparatus. The publication will be found of great interest to electrical men generally.

Bulletin No. 4893 is devoted to a general description of 2 automatic time switches manufactured by the General Electric Co. The bulletin contains diagrams and dimensions.

Bulletin No. 4901 is devoted to Alternating Current Switchboard Panels with Oil Switches attached, and designed for 3-phase, 3-wire circuits; 240, 480 and 600 volts, 25/60 cycles. This supersedes the company's previous bulletin on this subject.

Without doubt, the lighting of textile mills exerts an important influence on the amount and cost of production, the quality of the product, the amount of spoilage, the safety of the employees and their willingness and ability to furnish the best possible returns in labor.

Bulletin No. 4906 is devoted to the Lighting of Textile Mills. It describes the new drawn wire GE Edison Mazda Lamps, which are particularly suited to this class of illumination, contains illustrations of various installations of these lamps, and makes recommendations relative to the illumination of various departments of textile mills.

The General Electric Company's Bulletin No. 4904, illustrates and describes 3-phase panels for use in small or isolated plants containing but one generator. These panels are not intended for the parallel operation of generators, but for installation in a switchboard consisting of 2 or more panels.

Bulletin No. 4905 is devoted to panels designed for general use in small central stations and isolated plants, and are for use with one set of bus-bars, to which the generators and feeders are connected, and are suited to the parallel operation of generators.

BURY COMPRESSOR CO., of Erie, Pa., has reently installed at the foundry plant of the Erie Malleable Iron Works of the same city one its new variable volume air compressors of 1600 cu. ft. per minute capacity with bandwheel driven by belt from an electric motor to meet the variable volume conditions in the foundry plant. The installation has proved highly successful and greatly reduced the power cost.

GEO. B. CARPENTER & CO.'S Catalog No. 100, is a handsome book and gives a complete list of mill, lotte, N. C.; 1 12500 hp., Goodyear Tire & Rubber goods, rope and tackle, tools and apparatus for construction work, contractors, ship builders and ship chandlers supplies; 650 pages of condensed information on convenient apparatus, with full dimension and price lists on fine stock and substantially bound in levant. It will be found a convenience and a valuable book on the engineer's desk.

HYDRAULIC BENDERS is the title of a new and interesting 64 page 6 in. by 9 in. catalog devoted exclusively to hydraulic machines just published by The Watson-Stillman Co., 50 Church St., New York. Hydraulic benders are now commonly used for bending all kinds of rails, structural shapes, reinforcing rods, and pipe; for shaping automobile frames; for straightening rods or shafts while held between lathe centers, and in almost every other conceiveable place where heavy bending is to be done. Free copy will be mailed to interested parties requesting Catalog No. 83.

Sparks From The Advertising Pages

The way in which the letters have come in answering the questions regarding the advertisements which appeared in the May 1st and May 15th issues of Practical Engineer has been very gratifying. It shows that the readers are not only interested in the Advertising Section, but that they appreciate the fact that being in constant touch with it will enable them to keep pace with the most modern methods of power plant management. The winners of the 50 prizes will be announced in the June 15th issue.

The letters brought out one significant fact—a fact which many advertisers realize and are taking advantage of—the fact that carefully prepared copy and layout will invariably supercede the mere card and high-sounding statement irrespective of space and position.

While it was perfectly natural that the majority of the selected advertisements were those which occupied a full page, it was equally natural that some should have preferred certain half-pages and in a few cases even quarter-pages. Of course, the full page unit of space wins out ten times out of ten where other things are equal, but the reason that the smaller space was preferred occasionally was because the advertiser had made the most of the space he used. The same advertiser with a full page would have achieved even greater success.

Beginning with the June 15th issue, we shall publish several of the letters, selecting the ones which are as nearly representative as possible, so as to give an idea of the more general opinion of those who answered.

In a previous issue we called attention to the value of the advertisements from an educational standpoint.

The extent of the value to be derived, however, from these advertisements is largely dependent upon the reader himself. If he limits his reading and investigation to what the manufacturers can say in the comparatively small space of the advertisement alone, he limits the benefit he can get proportionately.

The student who visits the library does not stop with the descriptive catalog, even though it contains synopses of the contents of scores of books bearing upon his subject. He reads the synopses and selects therefrom the titles of books which will help him. Then he sends for them and studies them.

Likewise the engineer who is anxious to get all that he can in the way of self-betterment will not only read and study what the manufacturers have to say in their advertisements, but he will select those in which he is most interested—those which seem the most instructive—and write for the more comprehensive descriptive literature, which the manufacturer is always glad to send.

The manufacturers who advertise, publish more than mere price lists in their catalogs nowadays. The majority of them contain information that is exceedingly valuable to an engineer. Suggestions are made for reducing power costs—for increasing the efficiency of the modern power plant—for minimizing some of the disagreeble work which falls to the engineer himself and often deprives him of his evenings and holidays.

TRADE NOTES

AMONG THE RECENT orders for Swartwout rotary ball-bearing ventilators received by the Ohio Blower Company we find one for 34 6-in. ventilators from the Ralston Steel Car Company, Columbus, Ohio; 2 36-in. ventilators from the Irwin Cotton Mills, West Durham, N. C.; and 7 of the same type and size from the Forth Worth Traction Company, Fort Worth, Texas.

THE HOPPES MANUFACTURING CO., Springfield, Ohio, report the following recent sales of feed water heaters:

2 5000 hp., Fort Worth Ry. Co., Fort Worth, Texas; 3 7500 hp., Northern Ohio Traction Co., Akron, Ohio; 2 5000 hp., Indiana & Michigan Electric Co., South Bend, Ind.; 1 6000 hp., Portland (Ore.) Ry. Light & Power Co.; 1 15000 hp., Southern Power Co., Charlotte, N. C.; 1 12500 hp., Goodyear Tire & Rubber Co., Akron, Ohio; 1 4000 hp., Havana Elec. Ry. Co., Havana, Cuba.

IN A LETTER RECENTLY RECEIVED the United States Graphite Co., of Saginaw, Mich., calls attention to the danger of using in boilers for the purpose of scale loosening, ordinary cheap graphite paints, likely to have a large percentage of scale-forming material in them and will, therefore, make the difficulty with scale worse rather than to remedy it.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—As chief or operating engineer, 10 years' experience on all kinds of steam and electrical power plant machinery. Age, 38; temperate, steady and reliable. Chicago City and State of Minn. chief engineers' license. Address Box 228, Practical Engineer, Chicago, Ill. 6-1-1

POSITION WANTED—By young engineer with 3½ years experience, Corliss and high speed engines, turbines and water tube boilers. A. C. & D. C., I. C. S. course, good habits and industrious. References. Can show you Ohio license. Address Box 227, Practical Engineer, Chicago, Ill. 6-1-1

POSITION WANTED—By a college engineer, 31 years, single, with over 6 years' outside experience in the running and setting up of steam, gas and gasoline engines of all kinds. Address Box 226, Practical Engineer, Chicago, Ill. 6-1-1

Help Wanted

REPRESENTATIVES WANTED—Traveling representatives selling supplies to ice manufacturers and others engaged in the refrigerating industry, and who have spare time for an agreeable side line, can make advantageous arrangement by addressing A. Smit, Room 1004, 116 Nassau St., New York. 6-1-2

WANTED—FACTORY superintendent or production man to have entire charge of plant manufacturing high grade steam and gas engines. Address Box 225 Practical Engineer, Chicago, Ill. 6-1-1

AGENTS WANTED—WE WANT a live-wire agent, either engineer or specialty salesman in every town to furnish lists of names and take orders for Akron Metal Gaskets, the most complete line of metal gaskets made. Write for our proposition. Akron Metallic Gasket Company, Dept. PE., Akron, Ohio. tf

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. Write for particulars. Lippincott Co., Newark, N. J. tf

Wanted

WANTED—EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one and two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. tf

For Sale

FOR SALE—INDICATOR, REDUCING WHEEL, planimeter, best make, in fine order. Examination allowed before payment. Price low—in fact, a sacrifice. Address Mrs. N. L. Browning, East Orange, N. J. tf

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C.

VALUABLE INVENTIONS WANTED—Mail description for free opinion of patentability immediately. Patents bought or sold for interested parties. A. P. Connor, E. E. Registered Patent Attorney, Washington, D. C. 5-1-2

PATENTS OF VALUE—Prompt and efficient service. No misleading inducements. Expert in Mechanics, Book of Advice and Patent Office Rules free. Clements & Clements, Patent Attorneys, 727 Colorado Bldg., Washington, D. C 5-15-6

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

Educational and Instruction

FREE TUITION BY MAIL—Civil service, drawing, engineering, electric wiring, agricultural, poultry, real estate, automobile, law, normal, academic, bookkeeping, shorthand courses. Matriculation, $5. Write for our free plan. Apply to CARNEGIE COLLEGE, Rogers, Ohio. 5-15-6

Miscellaneous

SPECIAL NOTICE—THE SLIDE RULE Bargain Sale advertised in Practical Engineer May 1st, '12, page 77, will, on account of the unexpected demand and the small remaining stock, be discontinued June 10th, '12, and orders arriving after this date will be returned to the sender. L. Work, 108 North 19th St., Philadelphia, Pa. 6-1-1

IRON, BRASS and Aluminum Castings, Metal Specialties, Patterns, Models, Polishing, Plating and Japanning, North Chicago Tool Works, 65 Grove Ave., North Chicago, Ill.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1413 W. Jackson Blvd., Chicago Ill. tf

MAKE MONEY on the side. Here's your chance to pick out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf